



Energy  
A Continuing  
Bibliography  
with Indexes

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July 1979

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*IAA* (A-10000 Series)

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*STAR* (N-10000 Series)

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# ENERGY

A Continuing Bibliography

With Indexes

Issue 22

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced from April 1 through June 30, 1979 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA)*.



Scientific and Technical Information Branch  
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1979  
Washington, DC

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# INTRODUCTION

This issue of *Energy: A Continuing Bibliography with Indexes* (NASA SP-7043(22)) lists 1096 reports, journal articles, and other documents announced between April 1, 1979 and June 30, 1979 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. The first issue of this continuing bibliography was published in May 1974 and succeeding issues are published quarterly.

The coverage includes regional, national and international energy systems; research and development on fuels and other sources of energy; energy conversion, transport, transmission, distribution and storage, with special emphasis on use of hydrogen and of solar energy. Also included are methods of locating or using new energy resources. Of special interest is energy for heating, lighting, for powering aircraft, surface vehicles, or other machinery.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries* in that order. The citation, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR* including the original accession numbers from the respective announcement journals. This procedure, which saves time and money accounts for the slight variation in citation appearances.

Five indexes -- subject, personal author, corporate source, contract number, and report number -- are included. The indexes are of the cumulating type throughout the year, with the fourth quarterly publication containing abstracts for the fourth quarter and index references for the four quarterly publications.

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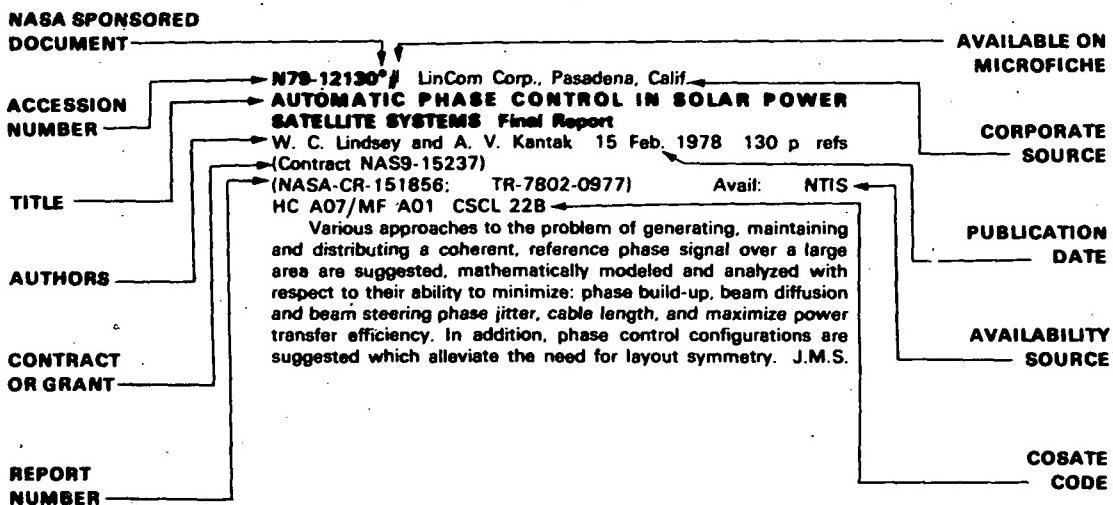
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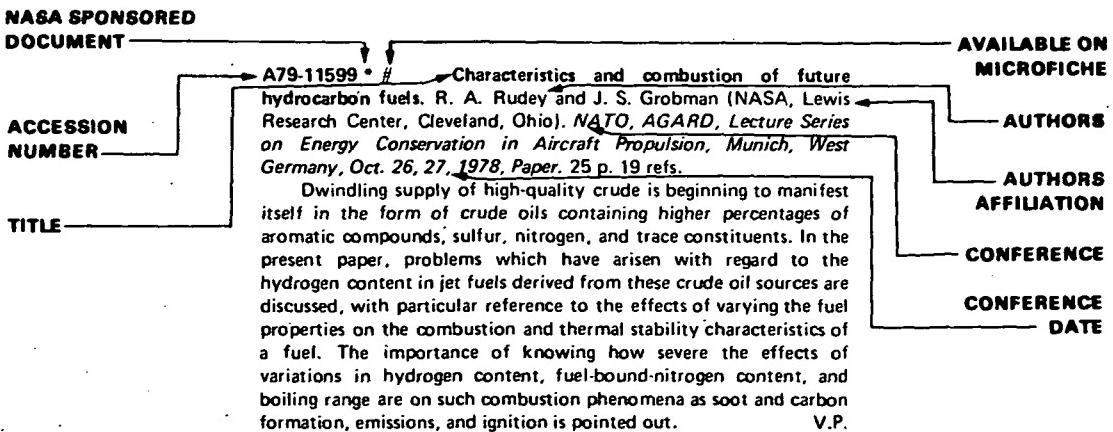
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## TYPICAL CITATION AND ABSTRACT FROM STAR



## TYPICAL CITATION AND ABSTRACT FROM IAA



## A Listing of Energy Bibliographies Contained In This Publication:

1. Cryogenic refrigeration, volume 2. A bibliography with abstracts p0331 N79-16144
2. Cryogenic refrigeration, volume 3. A bibliography with abstracts p0331 N79-16145
3. Oil pollution reports, volume 5, number 2 --- bibliographies p0336 N79-16437
4. Solar water pumps. Citations from the Engineering Index data base p0343 N79-17348
5. Optical coatings for solar cells and solar collectors. Citations from the NTIS data base p0350 N79-18465
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7. Synthetic fuels: Methane. Citations from the Engineering Index data base p0365 N79-21223

# ENERGY

A Continuing Bibliography (Issue 22)

JULY 1979

## IAA ENTRIES

**A79-20511** On vibration of a thick flexible ring rotating at high speed. C. W. Bert and T. L. C. Chen (Oklahoma, University, Norman, Okla.). (*U.S. National Congress of Applied Mechanics, 8th, University of California, Los Angeles, Calif., June 26-30, 1978.*) *Journal of Sound and Vibration*, vol. 61, Dec. 22, 1978, p. 517-530. 23 refs. Research supported by the U.S. Department of Energy.

In connection with high-performance flywheel energy storage systems containing a thick ring as the primary storage element, there is considerable current interest in the vibrational modes of such an element. In the present analysis both in-plane bending and coupled twisting/out-of-plane bending modes are considered. It is believed to be the first to include either transverse shear deformation or support restraint in the vibrational analysis of rotating rings. Numerical results are presented for a specific flywheel system currently under development. (Author)

**A79-20526** Applied Superconductivity Conference, Pittsburgh, Pa., September 25-28, 1978, Proceedings. Conference sponsored by APS, IEEE, DOE, NBS, et al. Edited by S. J. Saint Lorant (Stanford University, Stanford, Calif.). *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, 920 p.

Advances in technology and theory of magnets and magnetic components for a wide range of superconductivity applications are reported. The main areas studied include RF cavities and resonators; magnet stability; multifilament Nb<sub>3</sub>Sn composites; accelerator applications, magnets, and systems; superconducting power transmission and switching; practical multifilament Nb<sub>3</sub>Sn composites; conductor losses; submicrowatt devices; MHD and energy storage magnets; conductor stability; multifilament V3Ga, NbTi, and Nb<sub>3</sub>Sn; new materials such as Nb<sub>3</sub>Si and Nb<sub>3</sub>Ge; high-energy physics applications; superconducting machinery; large-scale conductors; utility applications; and fusion magnets and quench protection. P.T.H.

**A79-20530** Electric power losses of current input into superconducting devices cooled by supercritical helium. V. I. Maksimov and A. I. Malykhin (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 165-168. 8 refs.

This paper deals with the methods and results of calculations to minimize power losses in cryogenic installations related to current input into superconducting systems with forced supercritical helium cooling. Different schemes and modes of cooling the current leads with a superconducting region at the cold end are examined. Optimum helium flow rate and minimum power losses in an idealized and an actual cryogenic unit are defined. The calculations were made within the working temperature range of 5-18 K. The paper shows that the choice of the current lead cooling scheme allowing for minimum power losses depends on the relation between the temperatures of the superconducting device and of the superconducting transition in the superconducting region of the current lead. The value of minimum power losses decreases with the growth of the transient temperature in the superconducting region. (Author)

**A79-20531** Observation of voltage fluctuations in a Superconducting Magnet during MHD power generation. R. P. Smith, R. C. Niemann, M. R. Kraimer, and T. E. Zinnerman (Argonne National Laboratory, Argonne, Ill.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 295-297. 6 refs. Research supported by the U.S. Department of Energy.

Fluctuating voltage signals on the potential taps of the ANL 5.0 T MHD Superconducting Dipole Magnet have been observed during MHD power generation at the U-25B Facility at the High Temperature Institute (IVTAN) Moscow, USSR. Various other thermodynamic and electrical parameters of the U-25B flow train have been recorded, and statistical analysis concerning correlations between the phenomena with a view of discerning causal interdependence is in progress. Voltage fluctuations observed at the magnet terminals are analyzed with special emphasis on magnet stability. (Author)

**A79-20532** Design and operating experience of the cryogenic system of the U.S. SCMS as incorporated into the bypass loop of the U-25 MHD generator facility. R. C. Niemann, K. F. Matya (Argonne National Laboratory, Argonne, Ill.), D. A. McWilliams, R. Borden, M. H. Streete, R. Wickson (CTI-Cryogenics, Sudbury, Mass.), N. P. Privalov (Akademii Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR), and P. Smelser. (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 298-301. 8 refs. Research supported by the U.S. Department of Energy.

**A79-20533** A superconducting dipole magnet for the UTI MHD Facility. S.-T. Wang, R. C. Niemann, L. R. Turner, L. Genens, W. Pelczarski, J. Gonczy, J. Hoffman, Y.-C. Huang, N. Modjeski, and E. Kraft (Argonne National Laboratory, Argonne, Ill.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 302-305. Research supported by the U.S. Department of Energy.

The Argonne National Laboratory is designing and will build a large superconducting dipole magnet system for use in the Coal Fired Flow MHD Research Facility at the University of Tennessee Space Institute (UTSI). Presented in detail are the conceptual design of the magnet geometry, conductor design, cryostability evaluation, magnetic pressure computation, structural design, cryostat design, and the cryogenics system design. (Author)

**A79-20534** Fabrication and assembly considerations for a base load MHD superconducting magnet system. R. J. Thome, R. D. Pillsbury, J. W. Ayers, and T. M. Hrycaj (Magnetic Corporation of America, Waltham, Mass.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 306-309. Contract No. E(49-18)-2217.

**A79-20535** Practical aspects of designing and manufacturing MHD superconducting base-load magnets in 1988 time frame. S. L. Ackerman, C. E. Roye (General Dynamics Corp., Convair Div., San Diego, Calif.), R. N. Randall (Supercon, Inc., Natick, Mass.), and E. J. Rapperport (Magnetic Engineering Associates, Boston, Mass.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 310-313.

Manufacturing alternatives for three base-load MHD superconducting magnets are discussed. The three designs are two circular saddle concepts and a rectangular saddle concept. They are discussed with respect to insulation, substructure and superstructure, and final assembly operation. The circular design deals with force containment

in a more direct manner, utilizing the straight-line tensile paths of the shells and stave as opposed to the large moment generation inherent in the rectangular design. All three concepts use similar manufacturing methods, but circular designs minimize or simplify the respective manufacturing methods and result in better efficiency and lower cost.

P.T.H.

**A79-20536 Design criteria for multilayer superconductive magnets.** M. N. El Derini, M. A. Hilal, and R. W. Boom (Wisconsin University, Madison, Wis.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 314-317. Research supported by the U.S. Department of Energy.

High current round composite conductors with superconductors near the surface are under development at the University of Wisconsin. The conductors are designed for single layer energy storage solenoids and possibly for solenoids with several layers. The radial and axial forces in such magnets are obtained by summing forces between turns. Solenoids with constant tension are achieved by changing the spacing between conductors in the axial direction. Multilayer solenoids are designed so that the tension in the different layers is the same as the required design value. This design value is chosen to make the conductors remain in tension. Constant tension designs facilitate the economic use of force-bearing structure in energy storage and fusion superconductive magnets.

(Author)

**A79-20537 Superconducting energy storage magnets.** M. Masuda, T. Shintomi, H. Sato, and A. Kabe (National Laboratory for High Energy Physics, Tsukuba, Ibaraki, Japan). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 318-321. 7 refs.

The paper reports on an investigation of ac losses during pulsed operation of a 100 kJ superconducting energy storage system in which thyristors were used in place of a superconducting switch for peak shaving. The coil, which was not designed specifically for pulsed operation, was operated by trapezoidal current forms with various slopes. The coil was charged by rectifiers in the converter mode and discharged by them in the inverter mode. The ratio of electric power at charging and discharging was calculated as the energy storage efficiency, and experimental results were in good agreement with theoretical predictions. For a scale larger than 30 MWH for peak shaving, the prediction equation indicates 90% efficiency. A 3-MJ pulsed energy storage coil is under construction, which will be divided into three sections in order to protect the coil from quenching. The superconductor is Nb-Ti and the Cu/SC ratio is 3.0.

P.T.H.

**A79-20538 Heat pulses required to quench a potted superconducting magnet.** M. J. Superczynski (U.S. Naval Material Command, David W. Taylor Naval Ship Research and Development Center, Annapolis, Md.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 325-327.

A potted superconducting magnet was constructed and tested to determine the amount of energy, resulting from heat inputs to the magnet that tend to drive the magnet normal, required to quench the magnet. The solenoidal coil consisted of a 0.5-mm diameter multifilamentary Nb-Ti superconductor in a copper matrix, where the copper to superconductor ratio was 1.8:1, with 180 filaments and a twist pitch of 1 cm. The magnet was reinforced with fiberglass cloth and impregnated with epoxy resin. Energy pulses of different widths under different magnetic fields and current levels were input to the magnet to provide a wide spectrum of possible disturbances that could initiate a quench. Reducing the magnet design margin by increasing  $I/I_{\text{critical}}$  above 0.75 will severely reduce the stability of the magnet system. The absolute energy required to quench a magnet can be increased by reducing the overall current density or improving the thermal diffusivity of the total coil structure.

P.T.H.

**A79-20541 The role of the Large Coil Program in the development of superconducting magnets for fusion reactors.** P. N.

Haubenreich, J. N. Luton, and P. B. Thompson (Oak Ridge National Laboratory, Oak Ridge, Tenn.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 520-524. 7 refs. Contract No. W-7405-eng-26.

Toroidal field coils in a tokamak reactor face special problems of heat generation by pulsed poloidal fields, demands for continuity of operation, structural design to handle the asymmetric in-plane loading and the out-of-plane forces repeatedly imposed, and space competition that makes high current densities desirable. Large coils meeting tokamak requirements must be built and tested before an optimal choice can be made. This is being done through the LCP (Large Coil Program), in which three U.S. industrial teams are designing and will build one coil each to a common set of specifications. Each test coil will have a 2.5 x 3.5 m D-shape bore, will contain about 7 MA-turns, and must operate at a peak field of 8 T while subjected to pulsed fields up to 0.14 T in a test stand that can accommodate up to 6 coils in a compact toroidal array. Two coils will use different Nb-Ti conductors cooled by pool-boiling helium, while the third will use Nb<sub>3</sub>Sn cooled by a forced flow of supercritical helium.

(Author)

**A79-20542 Superconductivity for mirror fusion.** C. D. Henning (California University, Livermore, Calif.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 525-529. 11 refs. Contract No. W-7405-eng-48.

The largest advance in fusion magnets will be used in the Mirror Fusion Test Facility (MFTF) now under construction at LLL. Improvements in the technology of the previous LLL experiment, Baseball II, have been made using new conductor joining techniques, a ventilated wrap-around copper stabilizer, and stronger structural welding methods. The MFTF coil winding is proceeding on a separate former to allow parallel construction of the main structure. Not only does this shorten the project schedule to equal that of other conventional constructions, but a second vacuum barrier is created between the magnet helium and the plasma environment for reliable operation. In the future, LLL envisions a superconducting version of the Tandem Mirror Experiment and a possible hybrid reactor leading to economical fusion power.

(Author)

**A79-20543 Conceptual design of a superconducting tokamak - 'TORUS II SUPRA'.** R. Aymar, G. Claudet, C. Deck, R. Duthil, P. Genevey, C. Lefèuvre, J. C. Lottin, J. Parain, P. Seyfert, and A. Torossian (EURATOM and Commissariat à l'Energie Atomique sur la Fusion, Département de Physique du Plasma et de la Fusion Contrôlée, Fontenay-aux-Roses, Hauts-de-Seine, France). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 542-545. 6 refs.

The conceptual design of TORUS II SUPRA concerns a large-sized tokamak of the next generation. It takes into account constraints coming from the envisaged superconducting toroidal magnet, but keeps unchanged all the operational facilities and working conditions which a more conventional design, i.e., a water-cooled copper magnet, could offer. The main parameters are main radius equals 2.15 m, maximum plasma radius equals 0.75 m, magnetic field equals 4.5 T,  $I$  equals 1.7 MA. The scientific aims of the device concern the development, at a multimegawatt level, of plasma heating methods, mainly wave absorption and the contribution to high temperature (3-5 keV) tokamak physics allowed by these methods: main emphasis is put on tentative profile control of plasma parameters during the quasi-steady state possible with a dc toroidal magnetic field.

(Author)

**A79-20549 MIT-DOE program to demonstrate an advanced superconducting generator.** J. L. Smith, Jr., G. L. Wilson, and J. L. Kirtley, Jr. (MIT, Cambridge, Mass.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 727-730. 13 refs. Research supported by the U.S. Department of Energy.

A program is described which focuses on the construction of a 10-MVA experimental superconducting generator. The proposed machine incorporates advances in shielding of the superconducting winding, superconducting-winding design, rotor design, cryogenic cooling system, and high-voltage armature design. An overview of the experimental generator is given, emphasizing steady-state losses, dissipation, the two separate experimental damping systems, and armature cooling. Problems are considered which involve the losses associated with a step change in the field applied outside the field winding and its shielding system as well as the effect of the rotation of an externally applied magnetic-field vector relative to the superconductor. A three-dimensional finite-element program that models eddy currents in the conducting shells is discussed. F.G.M.

**A79-20555** 30-MJ superconducting magnetic energy storage /SMES/ unit for stabilizing an electric transmission system. J. D. Rogers, H. J. Boenig, J. C. Bronson, D. B. Colyer, W. V. Hassenzahl, R. D. Turner, and R. I. Schermer (California, University, Los Alamos, N. Mex.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 820-823. 13 refs. Research sponsored by the U.S. Department of Energy.

Electric power systems that have major loads and generation centers separated by large distances may experience low-frequency power oscillations. This type of oscillation has occurred on the Pacific AC Intertie that connects southern California and the Pacific Northwest. A separate almost-parallel dc transmission line also connects these areas. The Bonneville Power Administration, which operates this transmission system, has overcome the instability by controlling the power transmitted on the dc transmission line. A 30-MJ (8.4-kWh) superconducting magnetic energy storage unit with a 10-MW converter could also provide damping for this instability. The conceptual design of the 30-MJ coil and the cryogenic and electrical components of the system are described. The system is to operate at a maximum current of 5 kA and will modulate the AC Intertie at 0.35 Hz. Discharge will be controlled to retain a minimum stored energy of 20 MJ to limit cyclic strains in the coil and ac losses in the conductor. The conductor will be made of multistrand-copper and copper-matrix multifilament NbTi superconducting wires on a stainless steel mandrel. (Author)

**A79-20557** SLPX - Superconducting Long-Pulse Tokamak Experiment. D. L. Jassby, J. File, G. Bronner, J. R. Clarke, H. G. Johnson, G. D. Martin, J. G. Murray, M. Okabayashi, W. G. Price, Jr., and P. Rogoff (Princeton University, Princeton, N.J.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 847-850. 5 refs. Contract No. EY-76-C-02-3073.

The principal objectives of the SLPX (Superconducting Long Pulse Experiment) are: (1) to demonstrate quasi-steady operation of 3 to 5 MA hydrogen and deuterium tokamak plasmas at high temperature and high thermal wall loading, and (2) to develop reliable operation of prototypical tokamak reactor magnetics systems featuring a toroidal assembly of high-field niobium-tin coils, and a system of pulsed niobium-titanium superconducting poloidal-field coils. This paper describes the status of the engineering design features of the SLPX, with emphasis on the magnetics systems. The toroidal-field coils have an aperture of 3.1 m x 4.8 m, and can operate with a maximum field at the conductor of 12 T. The superconducting poloidal field magnetics system consists of a pulsed NbTi central solenoid, and a set of dc NbTi equilibrium-field coils. The entire machine is enclosed in an outer vacuum container equipped with re-entrant ports that provide ambient access to the room-temperature plasma vessel. (Author)

**A79-20658 #** Electromagnetic excitation of a moving conducting piston (Elektromagnitnoe vozvuzhdenie dvizhushchegosya provodniashchego porshnia). V. T. Chemeris and S. A. Gavrilko (Akademii Nauk Ukrainskoi SSR, Institut Elektrodinamiki, Kiev,

Ukrainian SSR). *Problemy Tekhnicheskoi Elektrodinamiki*, no. 66, 1978, p. 90-97. 10 refs. In Russian.

A theoretical analysis is presented of the cross-sectional current density distribution of a conducting piston moving in an external magnetic field in a pulsed induction-type MHD generator. Consideration is given to the difficulty of formulating boundary conditions for the current, associated with the necessity of preliminary determination of the rate of magnetic field diffusion into the piston. A mathematical model for calculating the rate of field diffusion as well as the distribution of current and fields in the piston and channel walls is presented. B.J.

**A79-20679 #** New chemical sources of current (Novye khimicheskie istochniki toka). N. V. Korovin. Moscow, Izdatel'stvo Energii, 1978. 184 p. 111 refs. In Russian.

The work describes the principles of operation of such devices as fuel cells, galvanic cells, and electrochemical generators. Particular consideration is given to the use of nonaqueous and solid electrolytes, the use of lithium-magnesium electrodes, the magnesium water-activated battery, thermal batteries, and hydrocarbon-air fuel cell batteries. Various applications of such devices are reviewed, including power plants and spacecraft power systems. B.J.

**A79-20700 \*** Energy conservation through sealing technology. W. K. Stair (Tennessee, University, Knoxville, Tenn.) and L. P. Ludwig (NASA, Lewis Research Center, Cleveland, Ohio). (*American Society of Lubrication Engineers, Annual Meeting, 33rd, Dearborn, Mich., Apr. 17-20, 1978.*) *Lubrication Engineering*, vol. 34, Nov. 1978, p. 618-624. 12 refs.

Improvements in fluid film sealing resulting from a proposed research program could lead to an annual energy saving, on a national basis, equivalent to about 37 million bbl of oil or 0.3% of the total U.S. energy consumption. Further, the application of known sealing technology can result in an annual saving of an additional 10 million bbl of oil. The energy saving would be accomplished by reduction in process heat energy loss, reduction of frictional energy generated and minimization of energy required to operate ancillary equipment associated with the seal system. In addition to energy saving, cost effectiveness is further enhanced by reduction in maintenance and in minimization of equipment for collecting leakage and for meeting environmental pollution standards. (Author)

**A79-20729** Tidal power in the Bay of Fundy. G. F. D. Duff (Toronto, University, Toronto, Canada). *Technology Review*, vol. 81, Nov. 1978, p. 34-42. 8 refs.

Details on the exploration of tidal energy, followed by a discussion of tidal technology and of the causes of tidal phenomena are presented with emphasis placed on the projected tidal power plant at Cumberland Basin on the Bay of Fundy, Canada, which will have a capacity of 1,085 MW. It has been estimated that for a 30-year period the cost/benefit ratio for the Cumberland Basin plant will be at 1:1.2. Beyond the electrical power that will be generated by the Cumberland Basin plant, a saving of 3 million barrels of fuel oil annually and of 380,000 tons of coal and some nuclear fuel would also be realized through the use of the power plant. Following the design, the plant will use a 'single effect' tidal barrier and a single basin to moderate the flow of tidal water. Construction could involve either of three methods: (1) floating in bulb turbines mounted in caissons, (2) building power houses and sluices behind dewatered cofferdams, and (3) building the power houses and sluices underground in a convenient headland and later removing natural rock plugs to open passageways for the water. The effects that the power plant might have on the environment are being studied though it is known that tidal power has minimal environmental side effects. A.A.

**A79-20730** Thermoclines: A solar thermal energy resource for enhanced hydroelectric power production. J. L. McNichols, W. S. Ginell (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.), and J. S. Cory (Cory Laboratories, Escondido, Calif.). *Science*, vol. 203, Jan. 12, 1979, p. 167, 168. 6 refs.

**A79-20746**

It is suggested that the solar thermal energy stored in hydroelectric reservoir freshwater thermoclines be used to increase the power output of conventional hydroelectric plants. Estimates of the amount of thermal energy stored and the efficiency of conversion into mechanical energy are considered, and thermocline data for three large reservoirs in western U.S. are presented. The adaptation of heat to hydroelectric facilities is recommended. M.L.

**A79-20746 Magnetic multipole line-cusp plasma generator for neutral beam injectors.** W. L. Stirling, P. M. Ryan, C. C. Tsai, and K. N. Leung (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *Review of Scientific Instruments*, vol. 50, Jan. 1979, p. 102-108. 19 refs. Contract No. W-7405-eng-26.

The magnetic multipole line-cusp device developed by MacKenzie and associates has been adapted for use as a neutral beam ion source. It has produced high-density, large volume, quiescent, uniform hydrogen plasmas, which makes it a potential candidate for use as a plasma generator for neutral beam injectors. The device is a water-cooled cylindrical copper discharge chamber (25 cm in diameter by 36 cm long) with one end enclosed by a set of extraction grids with a 15-cm-diam multiaperture pattern. The chamber wall serves as an anode and is surrounded by an external system of rare-earth cobalt magnets arranged in a line-cusp geometry of 12 cusps; plasma is produced by electron emission from a hot cathode assembly. This source has achieved extracted beam currents of 12 A at 18.5 kV, radial plasma density uniformities of + or - 5% over a 15-cm diameter, noise levels of less than + or - 0.5%, and arc efficiencies (beam current/arc power) of 0.6 A/kW. (Author)

**A79-20770 The thermochemical decomposition of water using bromine and iodine.** S. Mizuta, W. Kondo, T. Kumagai, and K. Fujii (National Chemical Laboratory for Industry, Tokyo, Japan). *International Journal of Hydrogen Energy*, vol. 3, Dec. 11, 1978, p. 407-417. 19 refs.

Thermochemical hydrogen production by the decomposition of water in a closed cycle that uses the combination of bromine or iodine with alkaline-earth metals was investigated. A thermodynamic analysis of the suitability of alkaline-earth metals to the bromine and iodine cycles is presented. These cycles consist of: the redox reaction of bromine (iodine), thermal decomposition of bromate (iodate), hydrolysis of bromide (iodide) and the thermal dissociation of hydrogen bromide (iodide). As a result of preliminary experiments, five new cycles (Mg-Ba-Br cycle, Mg-K-Br cycle, Mg-I cycle, Mg-Ca-I cycle and Mg-Ba-I cycle) are presented. (Author)

**A79-20771 Problems around Fe-Cl cycles.** D. van Velzen and H. Langenkamp (EURATOM and Comitato Nazionale per l'Energia Nucleare, Centro Comune di Ricerca, Ispra, Italy). *International Journal of Hydrogen Energy*, vol. 3, Dec. 11, 1978, p. 419-429. 21 refs.

Cycles for the thermochemical decomposition of water belonging to the Fe-Cl family have been considered potentially attractive. An analysis of the thermal efficiency, investments costs and development potential of this family is presented, where electrolysis of water serves as a reference process. It is concluded that the thermal efficiency of these cycles is probably considerably below the values obtained with direct electrolysis whereas investment costs are presumably higher by a factor of more than two. Main problem areas are situated in the hydrolysis of  $\text{FeCl}_2$  as well as in the thermal decomposition of  $\text{FeCl}_3$ . Both problems have to be solved simultaneously; finding a solution to only one will not be sufficient to build an attractive process. A number of possible alternative solutions to these problems are discussed. (Author)

**A79-20772 Thermodynamics of pressure plateaus in metal-hydrogen systems.** P. S. Rudman (Technion - Israel Institute of Technology, Haifa, Israel). *International Journal of Hydrogen Energy*, vol. 3, Dec. 11, 1978, p. 431-447. 8 refs. Research supported by the National Council for Research and Development and Kernforschungsanlage Jülich GmbH.

**A79-20773 The potential of liquid hydrogen as a military aircraft fuel.** W. T. Mikolowsky (Rand Corp., Washington, D.C.) and L. W. Noggle (USAF, Wright-Patterson AFB, Ohio). *International Journal of Hydrogen Energy*, vol. 3, Dec. 11, 1978, p. 449-460. 15 refs.

The paper is concerned with the possible use of liquid hydrogen as a fuel for very large aircraft (with maximum gross weights in excess of one million pounds). Life-cycle costs and life-cycle energy consumption for both synthetic jet-fuel and liquid hydrogen-fueled aircraft are compared, and it is found for these coal-derived fuels that synthetic jet fuel is more attractive than liquid hydrogen as a military aircraft fuel. Strategic airlift mission and station-keeping missions are considered. M.L.

**A79-20774 Some environmental and safety aspects of using hydrogen as a fuel.** G. D. Brewer (Lockheed-California Co., Burbank, Calif.). (*Commission of the European Communities, EURATOM Course, Ispra, Italy, May 9-13, 1977.*) *International Journal of Hydrogen Energy*, vol. 3, Dec. 11, 1978, p. 461-474. 7 refs.

The use of hydrogen as a fuel for road vehicles and for aircraft is discussed from the viewpoint of environmental and safety considerations. The current pattern of hydrogen use in industrial processes is described, and the use of hydrogen for energy transmission and for household appliances is considered. The problem of air pollution from aircraft is examined. M.L.

**A79-20796 # Experimental studies of a linear MHD generator with fully ionized seed.** H. Yamasaki, S. Shiota (Tokyo Institute of Technology, Tokyo, Japan), and Y. Masuhara. *Journal of Energy*, vol. 2, Nov.-Dec. 1978, p. 337-341. 11 refs.

Power generation experiments for a linear nonequilibrium Faraday generator with small seed fractions of .00001-.0001 have been conducted in order to show the recovery of the effective electrical conductivity and the power density due to the suppression of ionization instability and to demonstrate the possible operation of a linear MHD generator with fully ionized seed. Results of the experiments have shown the recovery of the apparent conductivity up to 20-27 mho/m, and the ratio of the apparent conductivity to the ideal conductivity decreases from 0.8 to 0.2 as the seed fraction increases from .00001-.00007. The high apparent conductivity indicates the possible operation of a linear generator with fully ionized seed, and the increase of isentropic efficiency of a closed-cycle inert-gas MHD generator can be expected. (Author)

**A79-20798 # Fluid dynamics of diffuser-augmented wind turbines.** B. L. Gilbert, R. A. Oman, and K. M. Foreman (Grumman Fluid Dynamics Laboratory, Bethpage, N.Y.). *Journal of Energy*, vol. 2, Nov.-Dec. 1978, p. 368-374. 6 refs. Contract No. E(11-1)-2616.

The diffuser-augmented wind turbine (DAWT) is one of the advanced concepts being investigated to improve the economics of wind energy conversion systems (WECS). Application of modern boundary-layer control techniques has reduced the surface area requirements of an efficient diffuser by an order of magnitude. Many parameters that affect the performance of the diffuser system have been examined in small-scale wind tunnel tests with a family of compact diffusers, using screens and centerbodies to simulate the presence of turbine. Flowfield surveys, overall performance, the effect of ground proximity, and the prospects for further improvement are described. The baseline configuration is a conical, 60 deg included angle diffuser with an area ratio of 2.78 controlled by two tangential injection slots. This first-generation DAWT can provide about twice the power of a conventional WECS with the same turbine diameter and wind. Economic estimates show that this DAWT can be as much as 50% cheaper than conventional WECS for the same rated power. (Author)

**A79-20799 # Universal generator storer curves.** A. V. da Rosa (CODETEC, Brazil; Stanford University, Stanford, Calif.). *Journal of Energy*, vol. 2, Nov.-Dec. 1978, p. 381, 382.

Some considerations regarding the optimization of relative sizes of generator and energy storage device of a solar photovoltaic system are presented. Curves are presented plotting the normalized effective collector area versus storage capacity and system cost versus peak array power for two different storage-system costs. B.J.

**A79-20800 # An inverse problem of vertical-axis wind turbines.** J. V. Healy (Belfast, Queen's University, Belfast, Northern Ireland). *Journal of Energy*, vol. 2, Nov.-Dec. 1978, p. 382-384. 5 refs.

The problem of choosing the most desirable lift and drag forces for a vertical-axis wind turbine is examined. The solution is obtained simply by specifying  $A = 1/3$  and  $C(p) = 16/27$  (where  $A$  is the inflow factor and  $C(p)$  is the maximum theoretical power coefficient), and solving for the lift and drag coefficients and the corresponding value of the angle of attack. It is found that even if it were possible to vary the angle of attack with angular position around the blade path, it would still be impossible to extract all the available energy. With the angle between the chord-line and the radial line fixed, this reduces the possibilities even further. B.J.

**A79-20801 Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978.** Symposium sponsored by the Society for the Advancement of Material and Process Engineering. Azusa, Calif., Society for the Advancement of Material and Process Engineering (Science of Advanced Materials and Process Engineering Series, Volume 23), 1978. 1257 p. \$40.

The commercial application of aerospace technology is considered along with the manufacturing cost/design guide, structural composites and adhesive materials, the fabrication of composite shell structure for advanced space transportation, aspects of testing, the role of materials in solar energy conversion, questions of windmill technology, new matrix materials for advanced composites, recent developments in the microstructural characterization of corrosion processes, and questions of high temperature corrosion. Attention is given to composite flywheels for energy storage, micro and macro mechanics formulas for composite materials, the flammability and toxicity of materials, advanced composite material in aircraft engines, sporting goods applications, the electromagnetic properties of composite and insulating materials, advanced composite material in aircraft and helicopters, and dimensionally stable structures. G.R.

**A79-20821 \* Recent developments in low cost silicon solar cells for terrestrial applications.** M. H. Leipold. In: *Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978.* Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 354-365. 33 refs. Research sponsored by the U.S. Department of Energy; Contract No. NAS7-100.

A variety of techniques may be used for photovoltaic energy systems. Concentrated or not concentrated sunlight may be employed, and a number of materials can be used, including silicon, gallium arsenide, cadmium sulfide, and cadmium telluride. Most of the experience, however, has been obtained with silicon cells employed without sunlight concentration. An industrial base exists at present for producing solar cells at a price in the range from \$15 to \$30 per peak watt. A major federal program has the objective to reduce the price of power provided by silicon solar systems to approximately \$1 per peak watt in the early 1980's and \$0.50 per watt by 1986. The approaches considered for achieving this objective are discussed. G.R.

**A79-20822 A ceramic heat exchanger for a Brayton cycle solar electric power plant.** J. D. Walton and J. N. Harris (Georgia Institute of Technology, Atlanta, Ga.). In: *Selective application of materials for products and energy; Proceedings of the Twenty-third*

National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 366-374. Research sponsored by the Electric Power Research Institute.

Solar thermal electric power systems collect and concentrate solar energy to heat a working fluid which is used to drive conventional Rankine or Brayton cycle turbine-generator equipment. A principal advantage of the central receiver system is the very high temperatures that can be produced in the working fluid. However, commercially available high temperature metal tube materials are not suitable for extended operation above about 1600 F. at the stress level expected in the high temperature heat exchanger. An investigation was, therefore, conducted with the objective to study suitable ceramic materials. It was found that silicon carbide U-tubes are suitable for use in a solar central receiver cavity type heat exchanger. G.R.

**A79-20823 # Suitable optical materials for solar collector applications.** J. E. Gilligan and J. Brzuskieicz (IIT Research Institute, Chicago, Ill.). In: *Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978.*

Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 375-385. Contract No. EY-76-C-02-0578-034.

The primary purpose of the described program is to determine the properties of solar energy utilization materials before and after exposure to outdoor weathering, and to obtain other relevant information including materials cost and availability. Ultimately, this program will provide designers and manufacturers of Solar Utilization (SU) devices with the appropriate data in handbook form to select cost-effective materials for their particular engineering designs, locations, and environments. Attention is given to the basic properties, nomenclature and measurement geometries, and bidirectional measurements. It is found that the role of materials in SU applications relates strongly to their initial properties, and to their durability. G.R.

**A79-20824 The thermomechanical behavior of polyvinyl butyral film and its effect on focal stability of a solar mirror-laminate.** A. M. Lindrose and T. R. Guess (Sandia Laboratories, Albuquerque, N. Mex.). In: *Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978.*

Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 386-402. Research supported by the U.S. Department of Energy.

**A79-20825 \* Background and system description of the Mod 1 wind turbine generator.** E. H. Ernst (General Electric Co., Valley Forge, Pa.). In: *Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978.* Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 403-408. Contract No. NAS3-20058.

The Mod-1 wind turbine considered is a large utility-class machine, operating in the high wind regime, which has the potential for generation of utility grade power at costs competitive with other alternative energy sources. A Mod-1 wind turbine generator (WTG) description is presented, taking into account the two variable-pitch steel blades of the rotor, the drive train, power generation/control, the Nacelle structure, and the yaw drive. The major surface elements of the WTG are the ground enclosure, the back-up battery system, the step-up transformer, elements of the data system, cabling, area lighting, and tower foundation. The final system weight (rotor, Nacelle, and tower) is expected to be about 650,000 pounds. The WTG will be capable of delivering 1800 kW to the utility grid in a wind-speed above 25 mph. G.R.

**A79-20826 \*** Wind turbine generator application places unique demands on tower design and materials. J. P. Kita (General Electric Co., Space Div., Valley Forge, Pa.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 409-416. Contract No. NAS3-20058.

The most relevant contractual tower design requirements and goal for the Mod-1 tower are related to steel truss tower construction, cost-effective state-of-the-art design, a design life of 30 years, and maximum wind conditions of 120 mph at 30 feet elevation. The Mod-1 tower design approach was an iterative process. Static design loads were calculated and member sizes and overall geometry chosen with the use of finite element computer techniques. Initial tower dynamic characteristics were then combined with the dynamic properties of the other wind turbine components, and a series of complex dynamic computer programs were run to establish a dynamic load set and then a second tower design. G.R.

**A79-20827 \*** Fatigue impact on Mod-1 wind turbine design. C. V. Stahle, Jr. (General Electric Co., Space Div., Valley Forge, Pa.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 417-427. Contract No. NAS3-20058.

Fatigue is a key consideration in the design of a long-life Wind Turbine Generator (WTG) system. This paper discusses the fatigue aspects of the large Mod-1 horizontal-axis WTG design starting with the characterization of the environment and proceeding through the design. Major sources of fatigue loading are discussed and methods of limiting fatigue loading are described. NASTRAN finite element models are used to determine dynamic loading and internal cyclic stresses. Recent developments in determining the allowable fatigue stress consistent with present construction codes are discussed relative to their application to WTG structural design. (Author)

**A79-20828 \*** Wind-turbine-generator rotor-blade concepts with low-cost potential. T. L. Sullivan, T. P. Cahill (NASA, Lewis Research Center, Cleveland, Ohio), D. G. Griffee, Jr. (NASA, Lewis Research Center, Cleveland, Ohio; United Technologies Corp., Hamilton Standard Div., Windsor Locks, Conn.), and H. W. Gewehr (NASA, Lewis Research Center, Cleveland, Ohio; Kaman Aerospace Corp., Bloomfield, Conn.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 428-456.

Four processes for producing blades are examined. Two use filament winding techniques and two involve filling a mold or form to produce all or part of a blade. The processes are described and a comparison is made of costs, material properties, designs and free vibration characteristics. Conclusions are made regarding the feasibility of each process to produce low-cost, structurally adequate blades. (Author)

**A79-20829 \*** An operating 200 kW horizontal axis wind turbine. C. L. Hunnicutt (Lockheed Aircraft Service Co., Ontario Calif.), B. Linscott, and R. A. Wolf (NASA, Lewis Research Center Cleveland, Ohio). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978.

Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 457-478.

Output from the 200-kilowatt machine will be enough to meet the power requirements of about 60 families. The experimental wind turbine generator (WTG) is a two-bladed, horizontal-axis, rotor system driving a synchronous electric generator through a step-up gear box located within a nacelle. The nacelle is mounted on top of a 100-foot tower with the rotor located downwind from the tower.

The 200-kilowatt rated power output of the wind turbine is achieved at a turbine rotor speed of 40 rpm and a rated wind speed of 18.3 mph. The rated wind speed is defined as the lowest wind speed at which full power is achieved. Attention is given to operational details, aspects of blade design, blade fabrication, the use of strain gages, questions of aeroelastic stability, and an early analysis of test data. G.R.

**A79-20838** Preliminary analysis of advanced ceramic magnetohydrodynamic /MHD/ combustor design concepts. E. L. Paquette (Atlantic Research Corp., Alexandria, Va.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 642-650.

The following design concepts of advanced ceramic MHD combustors are examined for engineering feasibility: uncooled ceramic-lined combustor, transpirationally cooled ceramic wall combustor, transpirationally shielded or consumable wall ceramic-lined combustors, and steam or air cooled ceramic-lined combustors. Feasible applications of ceramics to these design concepts are discussed. It is shown that the transpirationally cooled or shielded and the consumable wall ceramic-lined combustor concepts are impractical in terms of required flows, material removal rates, economics and reliability. The steam and air cooled ceramic-lined combustors appear to have immediate engineering feasibility. The uncooled ceramic design concept remains viable and essentially dependent on advances in ceramic material development related to selections. S.D.

**A79-20840** A composite-rim flywheel design. E. D. Reedy, Jr. (Sandia Laboratories, Albuquerque, N. Mex.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 663-674. 15 refs. Research supported by the U.S. Department of Energy.

The design of a flywheel incorporating a circumferentially wound rim is described. The flywheel is required to satisfy weight and size limitations which seem appropriate for utilization in a hybrid vehicle. Attention is given to the selection of materials and configuration for rim and hub, and to a method of attaching the rim to the hub. The rim material and design are chosen to optimize the rotor's energy storage capacity. Also, a method of fabricating prototype flywheels is described. Analysis of constant-thickness rims identified a graphite/epoxy rim with an inner-to-outer radius ratio of 0.775 as having the highest energy storage capacity of all design and material choices considered. This rim is used as the basis of a thick-rim flywheel design. The wagon wheel design incorporates a tubular aluminum hub and overwrapped Kevlar 49/epoxy bands. At 32,000 rpm, this flywheel can deliver 0.5-kWh energy with a three to one speed reduction. S.D.

**A79-20842** Composite material flywheel for the electric-powered passenger vehicle. D. A. Towgood and D. L. Satchwell (AiResearch Manufacturing Company of California, Torrance, Calif.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 703-711.

AiResearch has successfully operated a 23-in.-diameter, Kevlar-reinforced, epoxy flywheel in a design evaluation test for the Department of Energy electric-powered passenger vehicle. This composite material flywheel was subjected to 1000 deep acceleration-deceleration cycles of 12,500 to 25,000 rpm for two weeks. These accelerated life cycles represent an expected vehicle life of 10 years. The multiring flywheel is rim-mounted on a four-spoke aluminum hub. The rim comprises a set of nested, S-2 fiberglass

epoxy rings reinforced with Kevlar 29 and Kevlar 49. Candidate materials considered for this design will be compared in terms of mechanical properties and relative material costs per unit of stored energy.  
(Author)

**A79-20843** A status of the 'Alpha-ply' composite flywheel concept development. E. L. Lustenader and E. S. Zorzi (General Electric Co., Fairfield, Conn.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978.

Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 712-727.

The development of the pseudo-isotropic flywheel concept 'Alpha-ply' is discussed. Analytic and experimental results are presented, and the finite-element evaluation of the concept is described. The construction of the low-cost reliable and moderate-energy-density flywheel (potential energy density as high as 30 Wh/lb) consists of a layup of composite glass material into a uniform thickness disk. Reasons for the failure of the first 30-in. od E-glass/Kevlar-wrapped alpha 2 wheel are suggested. M.L.

**A79-20845** Flywheel energy accumulators for road vehicles. G. Hanselmann and E. Hau (M.A.N. Neue Technologie, Munich, West Germany). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978.

Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 740-747.

The technology of flywheel energy accumulators is discussed with reference to application in road vehicles. Choice of material, bearings and housing, safety, and cost of flywheels made from carbon or glass fibers are considered. The incorporation of a flywheel accumulator in drive systems containing either an internal combustion engine or a battery is examined, and the advantages provided by the flywheel are described. M.L.

**A79-20852** Composite material flywheels for energy storage on electricity supply systems. P. J. Worthington (Central Electricity Generating Board, Research Laboratories, Leatherhead, Surrey, England). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978.

Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 846-855. 12 refs.

The paper assesses the use of composite-material flywheels for large-scale storage of electricity. To achieve useful storage of about 10 MWh, large composite-material components need to be constructed and supported, and ancillary equipment developed to extract power from the flywheels. In particular, the costs of this method of storage are considered in order to evaluate the economic aspect of composite flywheels. A curve for useful energy stored vs flywheel mass is presented for different materials - Kevlar/epoxy, carbon/epoxy, glass/epoxy (all with about 60 vol% fiber) and steel. Another curve for tension/tension fatigue properties of unidirectional composites, with about 60 vol% fiber is given. Both a radially thin hoop wound rim and rods of aligned fibers mounted in a sweep's brush configuration for composite flywheel construction are discussed. S.D.

**A79-20853** Current status of composite flywheel development. R. H. Toland (California, University, Livermore, Calif.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978.

Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 856-876. 24 refs. Contract No. W-7405-eng-48.

The paper surveys the recent developments in the applications of fiber composite materials to flywheel energy storage systems. The impact of these materials on flywheel energy storage is discussed in relation to transportation systems, specifically the performance re-

quirements and the effect of system constraints on the ultimate effectiveness of the composite rotors. General flywheel design concepts are discussed in light of several performance criteria and the inherent design and material limitations, including those affecting reliability and life. Specific composite rotors that have been built and tested are discussed in terms of their demonstrated performance and are assessed for their potential. Also, recent government-sponsored research and development programs are briefly reviewed, and recommendations are made for future work.  
(Author)

**A79-20883 \*** Integral assembly of photovoltaic arrays using glass. P. R. Younger, A. R. Kirkpatrick (Spire Corp., Bedford, Mass.), H. G. Maxwell, and R. F. Holtze (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). Society for the Advancement of Material and Process Engineering, National Symposium and Exhibition, 23rd, Anaheim, Calif., May 2-4, 1978, Paper. 6 p. Research sponsored by the U.S. Department of Energy and NASA.

For a number of reasons glass is an excellent material for encapsulation of solar cell arrays. Glass can be readily available at relatively low cost. It exhibits excellent stability against degradation by solar ultraviolet illumination and atmospheric pollutants. A superior approach results if glass is employed directly as an integral encapsulant without secondary organic materials. A description is presented of a electrostatic bonding process which is being developed for integral assembly of glass encapsulated arrays. Solar cells are placed in contact with the glass surface, temperature is raised until the glass becomes ionically conductive, and an electric field is applied to initiate the bonding action. Silicon solar cells up to 3 inches in diameter have been integrally bonded without degradation. G.R.

**A79-20940** Optimization of a Knudsen Cs-Ba thermionic converter. V. I. Babanin, V. I. Kuznetsov, A. S. Mustafaev, V. I. Sitnov, and A. Ia. Ender (Akademii Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR). (Zhurnal Tekhnicheskoi Fiziki, vol. 48, Apr. 1978, p. 754-766.) Soviet Physics - Technical Physics, vol. 23, Apr. 1978, p. 444-451. 16 refs. Translation.

Consideration is given to the optimization of the saturation current and the power of a Cs-Ba thermionic converter operating in the Knudsen mode with surface ionization. An analysis is presented of potential distribution in the region of transition from a super-compensated to a subcompensated mode. A method for optimizing saturation current is presented and the maximum current of the thermionic converter is compared with the chaotic current in an equilibrium isothermal cavity. In developing a power-optimization procedure, a general volt-ampere characteristic is introduced which is used to determine the anodic work function and output power. Experimental data agree well with computational results and indicate that a Cs-Ba converter is highly efficient. B.J.

**A79-20941** Optimization of an ideal thermionic converter. A. S. Tirkov. (Zhurnal Tekhnicheskoi Fiziki, vol. 48, Apr. 1978, p. 767-769.) Soviet Physics - Technical Physics, vol. 23, Apr. 1978, p. 452, 453. 5 refs. Translation.

The problem of obtaining maximum output power is solved for an ideal thermionic converter with prescribed temperatures of emitter and collector and prescribed output current. An exact analytical expression is obtained for the limiting envelope of volt-ampere curves for an ideal converter; this expression can be used as a standard to evaluate the efficiency of real thermionic converters. As an example, calculations are conducted for the case of an emitter temperature of 2100 K and a collector temperature of 1050 K. A maximum output power of  $5 \times 10^{-8}$  W/sq cm is obtained.

B.J.

**A79-21056** Differential insulation and turbidity measurements. N. S. Lauainen, E. W. Kleckner, and J. J. Michalsky (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Conference on Atmospheric Radiation, 3rd, Davis, Calif., June 28-30, 1978, Preprints. Boston, Mass., American Meteorological Society, 1978, p. 130-133. Contract No. EY-76-C-06-1830.

## A79-21062

The Hanford area provides a unique opportunity for characterization of turbidity because of the nearly 1-km altitude difference between the Rattlesnake Observatory and the Hanford Meteorological Station, and because of the large variability of atmospheric dust and haze in the Central Columbia Basin region. An experiment was conducted during summer 1977 with several types of solar radiation instruments, including pyranometers, multiple-wavelength solar photometers, and an active cavity radiometer. The study demonstrates the usefulness of operating several different types of solar radiation instruments for obtaining insolation and turbidity simultaneously. The need for making measurements of total diffuse sky radiation is indicated.

S.D.

**A79-21062** Measurement and modelling of shortwave radiation on inclined surfaces. J. E. Hay (British Columbia, University, Vancouver, Canada). In: Conference on Atmospheric Radiation, 3rd, Davis, Calif., June 28-30, 1978. Preprints.

Boston, Mass., American Meteorological Society, 1978, p. 150-153.

At Vancouver UBC (49 deg 15 min N, 123 deg 15 min W) and Toronto Woodbridge (43 deg 48 min N, 79 deg 33 min W), essentially identical shortwave radiation measurement programs are providing observed values of inclined surface irradiance for direct input into numerical models and for testing slope radiation calculation procedures. The paper describes the instrumentation and some of the characteristics of the observed data, along with a comparison of these data with values calculated by a variety of numerical approaches. The effect of inclining the pyranometers is eliminated by using specific correction factors. The measured data are summarized by comparing monthly mean values for the horizontal and south-facing surfaces with long-term averaged values. Numerical modeling is discussed relative to direct radiation on a slope, reflected radiation on a slope, and diffuse radiation on a slope. An attempt to parameterize the ratio of circumsolar to isotropically distributed radiation has resulted in the development of a fourth model termed the anisotropic diffusion-radiation model, characterized by reduced systematic and random errors in the calculated total shortwave radiation.

S.D.

**A79-21161** Analysis and design of a field of heliostats for a solar power plant. J. L. Abatut and A. Achaibou (CNRS, Laboratoire d'Automatique et d'Analyse des Systèmes, Toulouse, France). *Solar Energy*, vol. 21, no. 6, 1978, p. 453-463.

For the design of the mirror field for the CNRS (Centre National de la Recherche Scientifique) project of a several MWe solar energy conversion power plant, an analysis of this concentration system is proposed. Using simulation programs, the problems of the choice of an optimal height of the tower and a convenient slope of the field are solved. By analysing the variation of the thermal power during five test days, it is shown that subject to certain assumptions the maximum output power is about 10 MWe. (Author)

**A79-21162** The dependence of optical properties on the structural composition of solar absorbers - Gold black. P. O'Neill, A. Ignatiev, and C. Doland (Houston, University, Houston, Tex.). *Solar Energy*, vol. 21, no. 6, 1978, p. 465-468. 13 refs. Research supported by the University of Houston and ERDA.

**A79-21163** Optimal distribution of heat conducting material in the finned pipe solar energy collector. M. Kovarik (Commonwealth Scientific and Industrial Research Organization, Highett, Victoria, Australia). *Solar Energy*, vol. 21, no. 6, 1978, p. 477-484. 6 refs.

**A79-21164** Hourly vs daily method of computing insolation on inclined surfaces. M. Iqbal (British Columbia, University, Vancouver, Canada). *Solar Energy*, vol. 21, no. 6, 1978, p. 485-489. 14 refs. Research supported by the National Research Council of Canada.

Two methods of determining insolation on south-facing inclined planes are compared and are found to provide only slightly different results. One method uses hourly values of total and diffuse radiation obtained from experimental data, while the other procedure applies the Liu and Jordan method for obtaining daily insolation on surfaces tilted toward the equator. The differences in the calculated insolation are attributed to three factors, which are discussed. M.L.

**A79-21165** Computer based sun following system. B. P. Edwards (Australian National University, Canberra, Australia). *Solar Energy*, vol. 21, no. 6, 1978, p. 491-496. 6 refs.

A computer-based system controlling a large number of parabolic collectors for sunfollowing operation is examined. The system operates with the computer changing the speeds of each of the collector actuators in the field at regular intervals over the day. Sources of following error and procedures for minimizing the error are described. Accurate sun following is shown to require a data output from the central controller of only 500 bit/sec for 10,000 collectors. A computer-based learning procedure functionally equivalent to an alignment process is considered. M.L.

**A79-21166** Augmented solar energy collection using different types of planar reflective surfaces - Theoretical calculations and experimental results. D. P. Grimmer (California, University, Los Alamos, N. Mex.), K. G. Zinn (California, University, La Jolla, Calif.), K. C. Herr (Aerospace Corp., Los Angeles, Calif.), and B. E. Wood (Oregon, University, Eugene, Ore.). *Solar Energy*, vol. 21, no. 6, 1978, p. 497-501. 9 refs. ERDA-sponsored research.

The paper reports theoretical and experimental studies of the use of different types of flat reflective surfaces to increase the collection of solar energy by flat collectors. Specular, diffuse, and combination specular/diffuse reflective surfaces are discussed. The reflectivity properties of a given surface are measured as a function of incident and reflected angles, and on the basis of these measurements the computer model predicts the increase in collector performance with such a reflector. Calculated and experimental results are compared.

M.L.

**A79-21167** Diffuse solar radiation on a horizontal surface for a clear sky. R. O. Buckius and R. King (Illinois, University, Urbana, Ill.). *Solar Energy*, vol. 21, no. 6, 1978, p. 503-509. 24 refs. Research supported by the University of Illinois.

**A79-21168** Comparison of transient heat transfer models for flat plate collectors. N. E. Wijeyesundara (University of Sri Lanka, Peradeniya, Sri Lanka). *Solar Energy*, vol. 21, no. 6, 1978, p. 517-521.

**A79-21169** Energy storage using the reversible oxidation of barium oxide. R. G. Bowrey and J. Jutsen (New South Wales, University, Kensington, Australia). *Solar Energy*, vol. 21, no. 6, 1978, p. 523-525. 8 refs.

The thermodynamics of the BaO/BaO<sub>2</sub> system are surveyed, and three experiments involving BaO powder heated in electric furnaces were performed to study the practicality of the BaO/BaO<sub>2</sub> system for storing energy. It is concluded that the system is practical. Air can be used during both the oxidizing and the reducing steps as the heat transfer fluid and as either the oxygen source or the purging fluid. Suitable conditions for mass transfer are indicated. M.L.

**A79-21171** The application of thermography to large arrays of solar energy collectors. R. G. Mansfield and A. Eden (USAF, Dept. of Civil Engineering, Engineering Mechanics and Materials, Colorado Springs, Colo.). *Solar Energy*, vol. 21, no. 6, 1978, p. 533-537. 10 refs.

The paper describes the use of thermography to predict and observe flow problems within a large solar collector array. Application of thermography requires attention to wind velocity, ambient temperature, and reflected glare. It was found that thermographs represent a qualitative temperature distribution on absorption surfaces even though it is temperatures from the glass collectors

which are measured. Application of an infrared telephoto lens and cathode-ray tube to array maintenance, problem detection, and the study of the effects of flow rates is considered.

M.L.

**A79-21249 # Problems in the development of high-service-life capacitative accumulators (Problemy sozdaniia emkostnykh nакопитеlei s povыshennym srokom sluzhby).** S. L. Zaients, G. S. Kichaeva, G. S. Kuchinskii, G. G. Lysakovskii, P. G. Popov, V. A. Popova, O. V. Shilin, and G. A. Shneerson. *Akademika Nauk SSSR, Izvestia, Energetika i Transport*, Nov.-Dec. 1978, p. 3-8. 13 refs. In Russian.

The paper considers the development of high-power high-service-life pulsed-current generators (capacitative accumulators) used for supplying power to fusion reactors. Such devices are designed for powers of greater than 100 MJ and to perform for lifetimes of approximately 10 to the 8th pulses. Problems associated with the optimization of such devices are discussed. The cost effectiveness of 100-MJ current generators for magnetic-confinement fusion reactors is demonstrated.

B.J.

**A79-21259 # Financial/management scenarios for a satellite power system program.** J. P. Vajk, R. D. Stutzke, M. S. Klan (Science Applications, Inc., Pleasanton, Calif.), R. Salkeld, and G. H. Stine. *American Astronautical Society, Anniversary Conference, 25th, Houston, Tex., Oct. 30-Nov. 2, 1978, Paper 78-144.* 48 p. 23 refs. Contract No. EG-77-C-01-4024.

Ten different methods for financing the development of the satellite power system are examined. An analysis of the capital requirements suggests that the initial investment costs may total several tens of billions of dollars prior to return of commercially significant quantities of power. The 10 organizational forms considered involve existing government agencies, new government agency, taxpayer stock corporation, trust fund supported by energy taxes, federal agency supported by floating long-term bonds backed by the Treasury, the staging company concept, a government-chartered monopoly, the consortium model, the corporate socialism model, and the universal capitalism model.

M.L.

**A79-21265 # An evolutionary solar power satellite program.** G. M. Hanley and W. R. Rhote (Rockwell International Corp., Satellite Systems Div., Downey, Calif.). *American Astronautical Society, Anniversary Conference, 25th, Houston, Tex., Oct. 30-Nov. 2, 1978, Paper 78-153.* 19 p.

An evolutionary solar power satellite (SPS) development plan was prepared to satisfy stated objectives. In this paper, effort is mainly directed to amplification of the technology advancement phase of the SPS development plan for the projected time frame 1980-1990. The discussion focuses on the microwave exploratory research program, the SPS power conversion/distribution and structures technology, the SPS orbital test platform evolution at low earth orbit and geosynchronous earth orbit, and the pilot plant demonstration phase. A well-focused ground test program supported by key Shuttle sortie experiments during the period 1980-1985 can lead to the evolution of the SPS orbital test platform during the latter part of the decade. Completion of the SPS technology advancement phase of SPS development in 1990 will provide the technical confidence to proceed with the full-scale pilot-plant demonstration phase.

S.D.

**A79-21266 # A development strategy for the solar power satellite.** D. L. Gregory (Boeing Aerospace Co., Seattle, Wash.). *American Astronautical Society, Anniversary Conference, 25th, Houston, Tex., Oct. 30-Nov. 2, 1978, Paper 78-154.* 26 p.

An interdisciplinary study examined several problems associated with the solar power satellite (SPS) project, and the number of primary individual shuttle flights required to test the SPS concept is considered. It is suggested that a single sortie for launching a single large aperture satellite should be sufficient for providing proof of SPS concepts. The satellite and its role in studying developmental operations are described. After this project, which could be organized by about 1983, a later project, designed to assure success

of major flight projects, would involve three shuttle flight sorties to study a structural beam 'machine', an orbital work station, and high power elements.

M.L.

**A79-21270 \* # Costing the satellite power system.** G. A. Hazelrigg, Jr. (ECON, Inc., Princeton, N.J.). *American Astronautical Society, Anniversary Conference, 25th, Houston, Tex., Oct. 30-Nov. 2, 1978, Paper 78-166.* 23 p. 9 refs. Contract No. NAS8-3302.

The paper presents a methodology for satellite power system costing, places approximate limits on the accuracy possible in cost estimates made at this time, and outlines the use of probabilistic cost information in support of the decision-making process. Reasons for using probabilistic costing or risk analysis procedures instead of standard deterministic costing procedures are considered. Components of cost, costing estimating relationships, grass roots costing, and risk analysis are discussed. Risk analysis using a Monte Carlo simulation model is used to estimate future costs.

M.L.

**A79-21273 # Health maintenance and health surveillance considerations for an SPS space construction base community.** J. P. Kornberg, P. K. Chapman, and P. E. Glaser (Arthur-D. Little, Inc., Cambridge, Mass.). *American Astronautical Society, Anniversary Conference, 25th, Houston, Tex., Oct. 30-Nov. 2, 1978, Paper 78-176.* 13 p. 5 refs.

Successful development of the solar power satellite (SPS) would remove the limits to growth imposed by nonrenewable terrestrial energy resources. The requirements for the assembly and maintenance of the SPS are investigated. Construction costs, including transportation of the required construction crew of about 550 people and amortization of the bases, are projected to account for about 8% of the total SPS capital cost. The construction crew's primary activity would be monitoring, servicing, and repairing, with little need for extravehicular activities. It is anticipated that the crew will live and work in the SPS space construction base community, which will be capable of supporting all occupational and nonoccupational activities over extended periods. The most important goal to be met at the construction base is to guarantee the maintenance of the good health of the crew. Appropriate health maintenance and health surveillance activities are discussed.

G.R.

**A79-21275 # Future programs and prospects for resource exploration from space by the year 2000.** M. T. Halbouty. *American Astronautical Society, Anniversary Conference, 25th, Houston, Tex., Oct. 30-Nov. 2, 1978, Paper 78-182.* 21 p. 6 refs.

It is suggested that a national program should be organized to facilitate exploration of natural resources. The significance of remote sensing data obtained by aircraft and spacecraft is considered, and estimates of potential oil and gas reserves are examined with reference to geopolitics and the transition to the post-petroleum era. The importance of Landsat, which detects landscape lineaments and provides repetitive coverage of the earth's surface, is explained, and extension of remote sensing techniques is discussed.

M.L.

**A79-21300 \* # Thermal storage for industrial process and reject heat.** R. A. Duscha and W. J. Masica (NASA, Lewis Research Center, Cleveland, Ohio). *U.S. Department of Energy, Conference on Waste Heat Management and Utilization, 2nd, Miami Beach, Fla., Dec. 4-6, 1978, Paper 12*. 7 p. 7 refs. Contract No. EC-77-A-31-1034.

Industrial production uses about 40% of the total energy consumed in the United States. The major share of this is derived from fossil fuel. Potential savings of scarce fuel is possible through the use of thermal energy storage (TES) of reject or process heat for subsequent use. Results of study contracts awarded by the Department of Energy (DOE) and managed by the NASA Lewis Research Center have identified three especially significant industries where high temperature TES appears attractive - paper and pulp, iron and steel, and cement. Potential annual fuel savings with large scale implementation of near-term TES systems for these three industries is nearly 9 million bbl of oil.

(Author)

## A79-21302

**A79-21302 \* # Microprocessor control of a wind turbine generator.** A. J. Gnecco and G. T. Whitehead (NASA, Lewis Research Center, Cleveland, Ohio). *Institute of Electrical and Electronics Engineers, Conference on Industrial Applications of Microprocessors, Philadelphia, Pa., Mar. 20-22, 1978, Paper. 15 p.* Contract No. E(49-26)-1028.

This paper describes a microprocessor based system used to control the unattended operation of a wind turbine generator. The turbine and its microcomputer system are fully described with special emphasis on the wide variety of tasks performed by the microprocessor for the safe and efficient operation of the turbine. The flexibility, cost and reliability of the microprocessor were major factors in its selection. (Author)

**A79-21334 Wind power potential in the Pacific Northwest.** R. W. Baker, E. W. Hewson (Oregon State University, Corvallis, Ore.), N. G. Butler, and E. J. Warchol (Bonneville Power Administration, Portland, Ore.). *Journal of Applied Meteorology*, vol. 17, Dec. 1978, p. 1814-1825. 10 refs. Research supported by the Oregon Peoples Utility Districts Directors' Association and Eugene Water and Electric Board; Bonneville Power Administration Grant No. EW-78-C-80-1310.

The location, assessment, and potential of wind power resources in the Pacific Northwest are discussed. For assessment, 33 active data stations, ranging from strip chart recorders to simple wind run recorders, are used in addition to national weather service stations. Areas with proven potential include the coastal zone of Oregon and Washington and the adjoining offshore waters, the Columbia River Gorge and adjacent ridge tops running from central Washington to just east of Portland, and portions of northeastern Nevada. Several other high-elevation areas are thought to have high potential, but winds have not yet been measured. The durations of winds with suitable speeds is examined on a seasonal basis and for different weather conditions. Costs and output of different sizes of wind turbine generators are estimated. M.L.

**A79-21347 \* Hydrogen enrichment for low-emission jet combustion.** R. M. Clayton (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: *Evaporation-combustion of fuels*. Washington, D.C., American Chemical Society (Advances in Chemistry Series, No. 166), 1978, p. 267-286. 19 refs. Contract No. NAS7-100.

Simultaneous gaseous pollutant emission indexes (g pollutant/kg fuel) for a research combustor with inlet air at 120,900 N/sq m (11.9 atm) pressure and 727 K (849 F) temperature are as low as 1.0 for NO<sub>x</sub> and CO and 0.5 for unburned HC. Emissions data are presented for hydrogen/jet fuel (JP-5) mixes and for jet fuel only for premixed equivalence ratios from lean blowout to 0.65. Minimized emissions were achieved at an equivalence ratio of 0.38 using 10-12 mass percent hydrogen in the total fuel to depress the lean blowout limit. They were not achievable with jet fuel alone because of the onset of lean blowout at an equivalence ratio too high to reduce the NO<sub>x</sub> emission sufficiently. (Author)

**A79-21428 Properties of the plasma ions and the particle lifetime in ohmic heating in the L-2 stellarator.** M. S. Berezetskii, G. S. Voronov, S. E. Grebenshchikov, A. B. Izvozhikov, Iu. I. Nechaev, I. S. Sbitnikova, O. I. Fedanin, Iu. V. Khol'nov, A. V. Khudoleev, and I. S. Shpigel' (Akademii Nauk SSSR, Fizicheskii Institut, Moscow, USSR). (*Fizika Plazmy*, vol. 4, Mar.-Apr. 1978, p. 251-260.) *Soviet Journal of Plasma Physics*, vol. 4, Mar.-Apr. 1978, p. 138-143. 10 refs. Translation.

Ion temperature is studied as a function of the discharge properties. The energy removed from the ions through charge exchange and the ion energy lifetime are estimated. The lifetime is several times shorter than the neoclassical value. The density of neutral hydrogen in the plasma is determined. The lifetimes of the charged particles are estimated. (Author)

**A79-21429 Effect of the magnetic configuration of the poloidal diverter on the plasma in the T-12 finger-ring tokamak.** A.

V. Bortnikov, N. N. Brevnov, S. N. Gerasimov, V. G. Zhukovskii, N. V. Kuznetsov, V. I. Pergament, L. N. Khimchenko (Akademii Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR), W. C. Guss (Akademii Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR; General Atomic Co., San Diego, Calif.), and D. P. Hutchinson (Akademii Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR; Oak Ridge National Laboratory, Oak Ridge, Tenn.). (*Fizika Plazmy*, vol. 4, Mar.-Apr. 1978, p. 261-268.) *Soviet Journal of Plasma Physics*, vol. 4, Mar.-Apr. 1978, p. 144-148. Translation.

Experiments carried out in the T-12 finger-ring tokamak with two poloidal diverters are reported. The purpose of the experiments was to determine how the magnetic configuration of the poloidal diverter affects the physical properties of the plasma, the MHD stability, and the vertical stability. The results show that the configuration has a positive effect on the plasma properties and essentially no effect on MHD processes in the plasma (no effect on the evolution of  $m = 2$  perturbations or on the current disruption). (Author)

**A79-21430 Laser measurements of the radial profiles of the electron temperature and density in the FT-1 tokamak.** V. K. Gusev, V. S. Il'in, M. M. Larionov, A. D. Lebedev, L. S. Levin, Iu. K. Mikhailovskii, and G. T. Razdobarin (Akademii Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR). (*Fizika Plazmy*, vol. 4, Mar.-Apr. 1978, p. 269-274.) *Soviet Journal of Plasma Physics*, vol. 4, Mar.-Apr. 1978, p. 148-151. 5 refs. Translation.

The radial profiles and time evolution of the electron density and temperature in the FT-1 tokamak have been measured under conditions such that the average electron density in the discharge was  $5 \times 10^{12}$  per cu cm. A ruby laser with a pulse energy of 5 J was used. The observation solid angle was .015 sr. A pulsed multichannel spectrometer was used to detect the scattered-light spectrum. The radial profiles of the properties were recorded during ohmic heating of the plasma. A change in the profile of the electron temperature was detected when the RF pulse was applied to the plasma. (Author)

**A79-21432 Fast penetration of a magnetic field into a low-density plasma.** O. G. Parfenov and A. A. Shishko (Akademii Nauk SSSR, Institut Zemnogo Magnetizma, Ionosfery i Rasprostraneniia, Radiovoln, Irkutsk, USSR). (*Fizika Plazmy*, vol. 4, Mar.-Apr. 1978, p. 297-303.) *Soviet Journal of Plasma Physics*, vol. 4, Mar.-Apr. 1978, p. 165-168. 19 refs. Translation.

Energy transport across a magnetic field is studied experimentally and in a numerical MHD simulation. A self-consistent method for incorporating the results of the theory of plasma turbulence is described. The use of this method to study the formation of the fine structure of the front of a magnetosonic shock wave and the super-Alfvén penetration of a nonlinear magnetic perturbation into a low-density plasma is reported. An explanation is found for the basic experimental results obtained previously. Magnetothermal effects play an important role in intense plasma heating. (Author)

**A79-21433 Optimum properties of a noncylindrical pinch.** K. G. Gureev (Akademii Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). (*Fizika Plazmy*, vol. 4, Mar.-Apr. 1978, p. 304-314.) *Soviet Journal of Plasma Physics*, vol. 4, Mar.-Apr. 1978, p. 169-174. 13 refs. Translation.

The optimum properties of a noncylindrical pinch, for which the useful neutron energy exceeds the energy input, are determined. Two approaches are used to optimize the properties. The first approach is based on a simplified description of the configuration. In this approach, the basic physical properties in the pinch can be related to the parameters of the experimental apparatus analytically, without resorting to numerical calculations. In the second approach, numerical calculations model in detail the physical processes which occur in this system. The optimum properties found and confirmed in this manner differ markedly from those predicted earlier on the basis of empirical relations. (Author)

**A79-21434 Structure of the current shell in a Z pinch.** S. I. Ananin, V. V. Vikhrev, and N. V. Filippov (Akademii Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). (*Fizika Plazmy*, vol. 4, Mar.-Apr. 1978, p. 315-322.) *Soviet Journal of Plasma Physics*, vol. 4, Mar.-Apr. 1978, p. 175-179. 10 refs. Translation.

The current structure of the plasma shell is studied with magnetic probes and through a numerical simulation of the motion of the shell on the basis of three-fluid hydrodynamics. The good agreement between theory and experiment is evidence that this model correctly describes the processes occurring in the plasma shell of a Z pinch. (Author)

**A79-21443 Cyclotron-wave spectrum in a plasma with two ion species.** T. D. Kaladze and L. V. Tsamalashvili (Tbilisskii Gosudarstvennyi Universitet, Tiflis, Georgian SSR). (*Fizika Plazmy*, vol. 4, Mar.-Apr. 1978, p. 394-398.) *Soviet Journal of Plasma Physics*, vol. 4, Mar.-Apr. 1978, p. 222-224. 17 refs. Translation.

The dispersion relation is solved numerically for ion cyclotron waves propagating across the magnetic field in a plasma containing ions of two species (deuterium and tritium) for various ratios of plasma pressure to magnetic pressure. Ion cyclotron wave frequency is examined as a function of wave vector for beta = 1 and beta = 10. The problem is considered with respect to tokamak plasma conditions. B.J.

**A79-21473 # Optimal decisions for long-term operation of hydropower systems.** I. Seteanu and R. Popa (Bucuresti, Institutul Politehnic, Bucharest, Rumania). *Revue Roumaine des Sciences Techniques, Série Electrotechnique et Energétique*, vol. 23, Oct.-Dec. 1978, p. 489-499.

A dynamic programming model is described and applied to characterize the optimum long-term operation of a large reservoir which is part of a hydropower system. Although the approach is concerned with maximum performance for a period of several years, the results indicate procedures for maximizing the high-likelihood power on an annual basis. In the analysis, the maximum storage capacity is assumed to be 715 million cu m and the monthly average mandatory releases are assumed to be constant for each month. (Author)

**A79-21479 Performance of molten salt sodium/beta-alumina/SbCl<sub>3</sub> cells.** A. M. Chreitzberg, J. W. Consolloy, M. R. Manning, and J. C. Sklarchuk (ESB Technology Co., Yardley, Pa.). (*International Symposium on Molten Electrolytes and High Temperature Batteries*, Brighton, England, Sept. 22, 23, 1977.) *Journal of Power Sources*, vol. 3, Nov. 1978, p. 201-214. Research sponsored by the Electric Power Research Institute and ESB Ray-O-Vac Corp.

Twenty watt-hour size cells were tested at 180-260 °C to observe performance trends as a function of charge and discharge rate, temperature, and cycling on a 3 cycle-per-day routine. Major components of the test geometry were a carbon-steel outer sodium container, a beta alumina separator tube 2.5-cm o.d. by 15 cm long and with a 2 mm thick wall, spiral nickel or molybdenum brush current collectors, and a positive mix of carbon powder, sodium chloroaluminate, and antimony trichloride. Energy input and output, energy efficiency, and antimony utilization were monitored at discharge rates of 3, 5, 7, 10, and 14 hours and charge rates of 3, 5, 7, and 10 hours to 100% depth (4.0 V top of charge and 1.9 V bottom of discharge). Scaled up 50 and 80 Wh cells were constructed and tested. Projections of the performance of 200 Wh cells and the cost of a 100 MWh battery are given for utility load-leveling applications. (Author)

**A79-21480 A study of positive electrode materials for batteries operating in a halide-aluminate medium.** S. Maximovich, M. Levart, M. Fouletier, N. Nguyen, and G. Broncel (Grenoble, Ecole Nationale Supérieure d'Electrochimie et d'Electrométallurgie, Saint-Martin-d'Hères, Isère, France). *Journal of Power Sources*, vol. 3, Nov. 1978, p. 215-225. 12 refs. Research supported by the Direction des Recherches et d'Etudes Techniques.

Cathode behavior in halide-aluminate media was studied with attention focused on the oxidation and reduction processes of halide compounds. The cathodes were made from different carbon and graphite intercalation compounds. It is found that in chloride medium the reduction of fixed chlorine proceeds via two steps while in a mixed bromide-chloride medium a single reduction wave is observed. All cathode compounds tested showed degradation during charge-discharge cycling; the degradation is caused by a leaching out of intercalated halides. Thus, none of the tested compounds are suitable for secondary batteries. M.L.

**A79-21481 Casing materials for sodium/sulfur cells.** B. Hartmann (Brown, Boveri et Cie, AG, Heidelberg, West Germany). (*International Symposium on Molten Electrolytes and High Temperature Batteries*, Brighton, England, Sept. 22, 23, 1977.) *Journal of Power Sources*, vol. 3, Nov. 1978, p. 227-235. 10 refs. Research supported by the Bundesministerium für Forschung und Technologie.

Specifications for suitable casing materials for sodium/sulfur cells are discussed. In order to select the best materials, three types of experiments have been performed: static corrosion tests, experiments which used the samples as electrodes in Na<sub>2</sub>S<sub>4</sub>, and tests in Na/S cells. According to the results of the static corrosion tests the materials are arranged in three groups for practical reasons. Aluminum in contact with Na<sub>2</sub>S<sub>4</sub> at 350 °C develops an insulating layer. Corrosion layers formed on heavy metal alloys possess quite high conductivities. The structure of these layers is discussed. As the cell casing serves as a current collector, aluminum was coated with chromium containing iron, cobalt, or nickel alloys. Plasma spraying was used as the coating method. The usefulness of coated aluminum was demonstrated in Na/S cells. (Author)

**A79-21482 Influence of composition on the activity of tungsten carbide gas diffusion hydrogen electrodes.** I. Nikolov, L. Grigorov, T. Vitanov (Bulgarska Akademii na Naukite, Tsentralna Laboratoriia po Elektrokhimichni Iztochnitsi na Tok, Sofia, Bulgaria), M. Svata, and Z. Zabransky (Bulgarska Akademii na Naukite, Tsentralna Laboratoriia po Elektrokhimichni Iztochnitsi na Tok, Sofia, Bulgaria; Ceskoslovenska Akademie Ved, Ustav Fyzikalni Chemie a Elektrochemie, Prague, Czechoslovakia). *Journal of Power Sources*, vol. 3, Nov. 1978, p. 237-244. 10 refs.

**A79-21483 Influence of the electrolyte content of oxygen carbon gas-diffusion electrodes on their electro-chemical performance in acid solutions.** M. Musilova, J. Mrha (Ceskoslovenska Akademie Ved, Ustav Fyzikalni Chemie a Elektrochemie, Prague, Czechoslovakia), A. Kaisheva, I. Iliev, and S. Gambarzhev (Ceskoslovenska Akademie Ved, Ustav Fyzikalni Chemie a Elektrochemie, Prague, Czechoslovakia; Bulgarska Akademii na Naukite, Tsentralna Laboratoriia po Elektrokhimichni Iztochnitsi na Tok, Sofia, Bulgaria). *Journal of Power Sources*, vol. 3, Nov. 1978, p. 245-255. 7 refs.

**A79-21484 Silver selenate and silver tellurate as positive materials for lithium primary power sources.** F. Bonino, C. Forte, M. Lazzari (CNR, Centro di Studio Processi Elettrodici, Milan, Italy), and B. Scrosati (Roma, Università, Rome, Italy). *Journal of Power Sources*, vol. 3, Nov. 1978, p. 257-265. 20 refs. Research supported by the Consiglio Nazionale delle Ricerche.

The performances of button-type lithium cells based on Ag<sub>2</sub>SeO<sub>4</sub> and Ag<sub>2</sub>TeO<sub>4</sub> as cathodes have been determined in various organic electrolytes. These silver salts present relevant energetic properties and may be considered as interesting cathodic materials for application in primary lithium power sources. Information on the discharge processes has also been obtained by determining the electrode utilization at low rates and by X-ray analyses of the discharge products. Finally, Ag<sub>2</sub>SO<sub>4</sub> has been examined also as a cathode material in lithium cells. However, its performance was rather poor, probably because of a slight solubility in the electrolyte media considered. (Author)

## A79-21485

**A79-21485 Effect of electrolyte impurity on the electrochemical performance of the lead/tetrafluoroboric acid/lead dioxide cell.** J. E. Curtis and T. J. Sinclair (Royal Armament Research and Development Establishment, Fort Halstead, Kent, England). *Journal of Power Sources*, vol. 3, Nov. 1978, p. 267-276. 11 refs.

**A79-21486 Energy storage requirements for spacecraft.** M. G. Gandel (Lockheed Missiles and Space Co., Inc., Space Systems Div., Sunnyvale, Calif.). *Journal of Power Sources*, vol. 3, Nov. 1978, p. 277-289.

Spacecraft electrical power requirements are analyzed, and the constraints posed by these requirements on choice of prime power source and energy storage devices are examined. Characteristics of some electrical system power and storage devices are surveyed, and procedures for matching requirements with element and system properties are considered. Attention is directed to the use of batteries as energy storage devices. M.L.

**A79-21487 Differential scanning calorimetry studies of possible explosion-causing mixtures in Li/SO<sub>2</sub> cells.** W. P. Kilroy and S. Dallek (U.S. Navy, Naval Surface Weapons Center, Silver Spring, Md.). *Journal of Power Sources*, vol. 3, Nov. 1978, p. 291-295. 6 refs. Navy-supported research.

The reported qualitative study of exothermic reactions occurring among Li/SO<sub>2</sub> cell components and/or products of discharge is restricted to chemical combinations involving the lithium anode material. Differential scanning calorimetry data and curves are presented. Attention is focused on systems containing lithium and sulfur, lithium and LiAsF<sub>6</sub>, lithium and Li<sub>2</sub>S<sub>2</sub>O<sub>3</sub>, lithium and Teflon, and lithium and LiAsF<sub>6</sub>·4CH<sub>3</sub>CN. M.L.

**A79-21488 Recent advances in Na/S cell development - A review.** W. Fischer, W. Haar, B. Hartmann, H. Meinhold, and G. Weddigen (Brown, Boveri et Cie. AG, Heidelberg, West Germany). *Journal of Power Sources*, vol. 3, Dec. 1978, p. 299-309. 31 refs. Research supported by the Bundesministerium für Forschung und Technologie.

This paper describes recent progress in the development of sodium/sulfur batteries. Ceramic beta alumina electrolyte tubes with high conductivity and long life are being fabricated. Sulfur utilization is increased to 80%. Improvements are outlined which have been made in finding corrosion resistant casing materials and in cell design. Experimental cells with a weight of 1.1 kg and a capacity of 90 Wh have been built and successfully tested. Ninety-six of these cells have been electrically connected and enclosed in a conventional thermal insulation. The energy density of this nonoptimized battery was 36 Wh/kg at the 2.5 hour discharge rate. Optimization with respect to weight will result in batteries with an energy density of more than 100 Wh/kg. Further improvements in cycle life are necessary for the practical application of these batteries. (Author)

**A79-21489 Mathematics of coiling in cylindrical electrochemical cells - The theory of a spiral bounded by two circles and its application to the spiral-wound nickel-cadmium cell.** W. C. Maskell (Berec Group, Ltd., London, England). *Journal of Power Sources*, vol. 3, Dec. 1978, p. 311-329.

**A79-21490 Economic prospects for the application of new electric energy storage devices.** W. Fischer, H. B. Gels, F. Gross, K. Liermet, and F. J. Rohr (Brown, Boveri et Cie. AG, Heidelberg, West Germany). *Journal of Power Sources*, vol. 3, Dec. 1978, p. 331-345. 47 refs.

The technical and economic properties of new storage devices for electric energy such as batteries, hydrogen storage systems, flywheels, steam storage plants and compressed air storage facilities are compared with conventional peak power plants such as gas turbines and hydroelectric storage systems. The analysis shows that batteries, steam storage plants and compressed air storage facilities may be economically competitive with conventional peak power devices. Batteries are especially appropriate for dispersed energy

storage systems. Utilization of storage devices instead of gas turbines results in substitution of oil or natural gas by coal or nuclear fuel. (Author)

**A79-21491 On the possibility of using silver salts other than Ag<sub>2</sub>CrO<sub>4</sub> in organic lithium cells.** P. Cignini, M. Icovì, S. Panero, and G. Pistoia (Roma, Università, Rome, Italy). *Journal of Power Sources*, vol. 3, Dec. 1978, p. 347-357. 23 refs. Research supported by the Consiglio Nazionale delle Ricerche.

Several silver salts, including compounds listed in the literature and new compounds, have been examined to ascertain if their performances as cathodes for lithium cells could exceed that of Ag<sub>2</sub>CrO<sub>4</sub>. Discharges at various rates, polarization and cyclic voltammetry experiments were used to characterize their behavior. Coulombic and X-ray analysis have enabled information to be obtained on the discharge reactions but the reductions of the anions still have uncertain features. Of the compounds examined, Ag<sub>4</sub>P<sub>2</sub>O<sub>7</sub> is the most promising one, especially by virtue of a higher load voltage. Ag<sub>5</sub>I<sub>6</sub> and AgI<sub>3</sub>, at low rates, and AgI<sub>4</sub>, at high rates, also approach the performance of Ag<sub>2</sub>CrO<sub>4</sub>. (Author)

**A79-21532 # Investigation of the Hall effect in a discharge with a rotational electric field (Issledovanie effekta Kholla v razriade s vikhrevym elektricheskim polem).** A. P. Zhilinskii, B. V. Kuteev, A. S. Smirnov, and R. Sh. Tukhvatulin (Leningradskii Politekhnicheskii Institut, Leningrad, USSR). *Zhurnal Tekhnicheskoi Fiziki*, vol. 48, Oct. 1978, p. 2044-2046. In Russian.

It is shown experimentally that large values of the Hall parameter can be obtained in an electrodeless dc discharge. In this case, the plasma, formed directly in the magnetic field, was quasi-stationary. Measurements were carried out always in the active stage of the discharge, so that the influence of plasma decay on the measurement of the effective Hall parameter was eliminated. V.P.

**A79-21533 # Turbulence of a combustion product plasma in an MHD channel (O turbuljentnosti plazmy produktov sgoraniia v MGD kanale).** A. I. Bystryi, R. V. Ganefel'd, and V. B. Red'kin (Akademii Nauk Ukrainskoi SSR, Institut Elektrodinamiki, Kiev, Ukrainian SSR). *Zhurnal Tekhnicheskoi Fiziki*, vol. 48, Oct. 1978, p. 2074-2079. 6 refs. In Russian.

In the experiment described, the level and scale of turbulence and its correlation and spectral characteristics were studied for a combustion product plasma in an MHD channel. The manner in which the magnetic and electric fields affect the turbulence structure is illustrated. V.P.

**A79-21542 # Contribution to the theory of the pulsed mode of operation of the thermionic energy converter. II (K teorii impul'snogo rezhima termoemissionnogo preobrazovatelya energii. II).** V. A. Zherebtsov and V. D. Talanova. *Zhurnal Tekhnicheskoi Fiziki*, vol. 48, Oct. 1978, p. 2103-2112. 11 refs. In Russian.

The ionization process occurring in a thermionic energy converter operating in the pulsed mode is analyzed in the case where a negative voltage pulse is applied to the anode. In the case of a one-component filling of the diode, ions are produced in the anode sheath. This impairs considerably the effectiveness of their utilization during the plasma decay stage. When the diode is filled with heavy inert gases, the energy losses by ion production are as high as 60 eV. In the case of a two-component filling, the ionization region widens while the energy losses by ion production are reduced. V.P.

**A79-21585 # Experimental study of the characteristics of heat and mass transfer in a two-component low-temperature heat pipe (Eksperimental'noe izuchenie osobennostei teplo- i massoobmena v dvukhkomponentnoi nizkotemperaturnoi teplovoy trubke).** Ia. M. Baum, V. P. Sorokin, and S. S. Iurov. *Inzhenero-Fizicheskii Zhurnal*, vol. 35, Dec. 1978, p. 1034-1043. 11 refs. In Russian.

Experimental results are presented on a heat pipe with varying component concentrations of the heat-carrying fluid, a mixture of

water and ethanol. A qualitative model is presented for the mechanism of mass transfer in the evaporator; according to the model the mean-mass concentration of components in each cross section is determined by the interaction of vapor flows. It is found that the maximum power of a two-component pipe significantly exceeds that of a pipe with ethanol alone as the heat-carrying fluid. Neither the transferred power nor the intensity of evaporation and condensation has a significant effect on the degree of component separation in the heat pipe.

B.J.

**A79-21626 Nonstationary two-dimensional magnetohydrodynamic flow in a radial channel.** N. P. Gridnev and S. S. Katsnel'son. (*Magnitnaya Gidrodinamika*, Apr.-June 1978, p. 77-82.) *Magnetohydrodynamics*, vol. 14, no. 2, Dec. 1978, p. 200-205. 9 refs. Translation.

The present analysis deals with the situation where the flow generated in a cylindrical tube by the passage of a shock wave through an inert gas with an alkali metal addition issues into a disk-shaped MHD channel. The complex interaction of the expanding plasma flow with the magnetic field is analyzed, and a finite-difference scheme of third order accuracy, with a uniform time step, is proposed for calculating the shock interactions. For illustration, the flow is calculated for conditions where both the magnetic Reynolds number and the Hall parameter are small.

V.P.

**A79-21627 Accounting for the effect of a yoke in an MHD linear induction machine by stipulating boundary conditions of a new kind.** A. Ia. Vilnits. (*Magnitnaya Gidrodinamika*, Apr.-June 1978, p. 87-96.) *Magnetohydrodynamics*, vol. 14, no. 2, Dec. 1978, p. 210-219. 19 refs. Translation.

In the present paper, the action of the magnetic yoke of a linear MHD-machine is expressed by introducing a new type of boundary conditions in the form of a stepped normal induction component. This, together with the passage to a 'thin' working fluid at the limit, makes it possible to reduce the regions of both the working fluid and the yoke to lines (traces) with specified boundary conditions, assuming all the while that the Laplace equation is satisfied everywhere else. The new boundary conditions can be obtained by Fourier transforms with respect to the longitudinal coordinate. For an infinite yoke, the solution is shown to be rational. The case of a finite yoke leads to an integral equation or to an infinite system of algebraic equations.

V.P.

**A79-21628 Optimization of a diagonal MHD channel.** D. A. But, I. I. Doperchuk, and S. M.-A. Koneev. (*Magnitnaya Gidrodinamika*, Apr.-June 1978, p. 110-116.) *Magnetohydrodynamics*, vol. 14, no. 2, Dec. 1978, p. 231-237. 13 refs. Translation.

In the present paper, a diagonal MHD-channel is optimized with allowance for transient turbulent boundary layers and boundary layer separation, placing constraints on the channel geometry, the magnetic field, and some other parameters of the problem. Optimization is achieved by a nonlinear programming method, termed the method of moving tolerances, modified to improve the convergence of the iterations. It is shown that the value of the conversion coefficient can be increased by 10 to 12% by rational profiling of the channel and electrode walls.

V.P.

**A79-21667 Experimental investigations of a physical system capable of using solar energy.** R. Rup (Delhi, University, Delhi, India). *Journal of Physics D - Applied Physics*, vol. 11, Dec. 21, 1978, p. L207-L209.

A simple low-cost physical system capable of working at low temperature differences can be used profitably with a flat-plate solar collector. One such system, reported by West (1974), uses regenerative oscillations set up in the water columns in the three limbs of the system which presumably uses a Stirling cycle with air as the working fluid. Preliminary experiments were carried out which showed that,

for low temperature differences of the working fluid on either side of the regenerator, water vapor in the working fluid played an important role. Subsequently, a simple theoretical model was used to work out the dynamics of the system with two working fluids - dry air (dry system) and air saturated with water vapor (wet system). The present report shows that there is good agreement between theoretical and experimental results for both the dry and wet system.

B.J.

**A79-21676 Hydrides for energy storage; Proceedings of the International Symposium.** Geilo, Norway, August 14-19, 1977. Symposium sponsored by the Institutt for Atomenergi and Allied Chemical Corp. Edited by A. F. Anderson (Institutt for Atomenergi, Kjeller, Norway) and A. J. Maeland (Allied Chemical Corp., Morristown, N.J.). Oxford, Pergamon Press, Ltd., 1978. 611 p. \$60.

Consideration is given to the prospects of hydrogen as an energy carrier for the future, structure and bonding in metal hydrides, the nature of He-3 confinement in transition metal hydrides, hydrogen adsorption in rare earth intermetallic compounds, and the use of FeTi-hydrides for production and storage of suprapure hydrogen. Papers are also presented on such topics as hysteresis effects in metal-hydrogen systems, electrochemical utilization of metal hydrides, hydrogen storage electrode systems, the hydrogen/hydride energy concept, and the metallurgy and production of rechargeable hydrides.

B.J.

**A79-21677 The prospects of hydrogen as an energy carrier for the future.** G. G. Libowitz (Allied Chemical Corp., Morristown, N.J.). In: *Hydrides for energy storage; Proceedings of the International Symposium*, Geilo, Norway, August 14-19, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 1-17. 36 refs.

An indication of some of the scientific problems and possible solutions associated with the development of a hydrogen economy is presented. Emphasis is on materials problems which may be associated with the generation, utilization, and transmission and storage of hydrogen. This includes a discussion of such topics as catalysis, solid state electrolysis, photoelectrolysis, thermochemical generation of hydrogen, and metal-hydrogen interactions.

B.J.

**A79-21678 Survey of the different types of hydrides.** A. J. Maeland (Allied Chemical Corp., Morristown, N.J.). In: *Hydrides for energy storage; Proceedings of the International Symposium*, Geilo, Norway, August 14-19, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 19-31. 35 refs.

Binary hydrides, classified according to bonding as saline, metallic, and covalent, are reviewed with respect to structure and thermodynamic properties. Hydrides of intermetallic compounds (considered as pseudo-binary hydrides) are included in the survey. Pressure-composition isotherms are presented for metal-hydrogen systems. The study has relevance to hydrogen energy development.

B.J.

**A79-21679 Structure and bonding in metal hydrides.** W. E. Wallace and S. K. Malik (Pittsburgh, University, Pittsburgh, Pa.). In: *Hydrides for energy storage; Proceedings of the International Symposium*, Geilo, Norway, August 14-19, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 33-42. 23 refs.

Research supported by the Petroleum Research Fund.

Bonding in hydrides of alkali metals, alkaline earth metals and of Eu and Yb is essentially ionic in nature and hydrogen in these materials is anionic. This is indicated by the structures, stoichiometries, and lattice energies of these hydrides. Recent work on the band structure of transition metal hydrides indicates that the simple protonic model is incorrect. Hydrogen participates, along with the ion cores of the host metal, in establishing the potential within which the delocalized electrons move. Hydrogen contributes states as well as electrons, in contrast to its behavior in the protonic model, where it contributes only electrons. Special complexities which can arise for substoichiometric hydrides are illustrated by reference to the Ta<sub>2</sub>H system.

B.J.

## A79-21680

**A79-21680 Thermodynamics of metal, alloy and intermetallic/hydrogen systems.** T. B. Flanagan (Vermont, University, Burlington, Vt.). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 43-59. 39 refs. NSF-supported research.

The thermodynamics of solution of hydrogen in metals (alloys or intermetallics) is reviewed for single phase regions of solubility. Consideration is given to the conversion of experimental data from conditions of essentially constant pressure to conditions of constant volume. The fundamental significance of thermodynamic parameters obtained from the temperature dependence of the two-phase coexistence pressures is examined and the necessary criteria for which these values correspond to the thermodynamics of the reaction  $1/2\text{H}_2(\text{g}) + \text{M}(\text{H-saturated})$  yields metal hydride are developed. Some experimental methods are reviewed. B.J.

**A79-21681 Structural studies of hydrides by neutron diffraction.** A. F. Andresen (Institutt for Atomenergi, Kjeller, Norway). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 61-72. 15 refs.

The application of neutron diffraction to the study of hydride structures is reviewed. Particular consideration is given to powder neutron diffraction, difficulties associated with the neutron diffraction investigation of hydrides, and some special applications of this technique. Emphasis is placed on some of the hydrides which are of interest for energy storage, including  $\text{CaH}_2$  and  $\text{La-Ni}$  hydrides. B.J.

**A79-21682 Localization and diffusion of hydrogen in lanthanum-nickel compounds.** A. Furrer, P. Fischer, W. Halg (Eidgenössische Technische Hochschule, Würenlingen, Switzerland), and L. Schlapbach (Eidgenössische Technische Hochschule, Zurich, Switzerland). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 73-82. 11 refs.

The static and dynamic properties of hydrogen in  $\text{La-Ni}$  compounds with different hydrogen contents have been studied by means of thermal neutron scattering. The hydrogen positions as well as the occupation numbers of the hydrogen sites in  $\text{LaNi}_5\text{H}(x)$  and  $\text{La}_7\text{Ni}_3\text{H}(x)$  have been determined by neutron diffraction using deuterated samples. The neutron inelastic scattering technique has been used to study the hydrogen diffusion process in  $\text{LaNi}_5\text{H}(x)$  by observing the width of the quasi-elastic line as a function of momentum transfer. The results are in qualitative agreement with the predictions of a jump diffusion model, and the diffusion parameters are correlated to the structure information obtained from the present neutron diffraction experiments. (Author)

**A79-21683 Nuclear magnetic resonance studies of metal hydrides.** B. Pedersen (Norges Teknisk-Naturvitenskapelige Forskningsråd, Senterinstitutt for Industriell Forskning; Oslo, Universitetet, Oslo, Norway). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 83-95. 26 refs.

Low temperature proton spectra give information on the crystal structure of metal hydrides. At higher temperatures, the proton spectrum is narrowed by hydrogen self-diffusion in all hydrides studied. Both the mean lifetime of a hydrogen atom in a site and the mean distance a hydrogen atom jumps can be determined by NMR spectroscopy, giving detailed information on the diffusion process. Observed shifts of the proton resonance frequency and the meta resonance frequency give information on the electron structure. B.J.

**A79-21684 NMR studies of hydrogen relaxation and diffusion in  $\text{TiFeH}/x$  and  $\text{TiFe}/1-y/\text{Mn}/y/\text{H}/x$ .** R. C. Bowman, Jr., A. Attalla (Monsanto Research Corp., Miamisburg, Ohio), G. C. Carter (National Bureau of Standards, Institute for Materials Re-

search, Gaithersburg, Md.), and Y. Chabre (Grenoble I, Université, Grenoble, France). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 97-118.

24 refs. Army-supported research; Contract No. EY-76-C-04-0053.

Various NMR parameters were measured in the hydride phase produced for  $\text{TiFe}$  and  $\text{TiFe}(0.79)\text{Mn}(0.15)$ . At low temperatures, interactions with conduction electrons dominate proton spin-lattice relaxation times for both beta and gamma phases. Spin echo measurements on beta-phase samples showed motional narrowing above 360 K and yielded a diffusion activation energy of  $0.26(2)$  eV. Hydrogen diffusion in the gamma phase is observed to be slower and an approximate activation energy of  $0.80(5)$  eV is deduced from relaxation time measurements. B.J.

**A79-21685 Electronic structure and physical properties of Ti-H and Zr-H using NMR.** C. Korn (Negev, University, Beersheba, Israel). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 119-122.

The spin lattice relaxation time of hydrogen in Zr-H was measured at room temperature as a function of hydrogen concentration in the x range of  $1.54-2.00$ , where x is the atomic hydrogen to zirconium ratio.  $(T1T)^{\exp -1/2}$ , a measure of the density of states at the Fermi level, shows a sharp peak at  $x = 1.8$  (similar to that found for Ti-H) and a discontinuity at  $x = 1.65$ . The concentration dependence of  $(T1T)^{\exp -1/2}$  is compared for the Ti-H and Zr-H systems and discussed in the light of a model for hydride electronic structure. The present measurements support the prediction of increased band splitting for Zr-H as proposed in the model. B.J.

**A79-21686 Electronic states of concentrated Pd-H alloys from de Haas-van Alphen measurements.** R. Griessen, W. J. Venema (Amsterdam, Vrije Universiteit, Amsterdam, Netherlands), J. K. Jacobs, and F. D. Manchester (Toronto, University, Toronto, Canada). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 123-127. 14 refs.

Results are presented on de Haas-van Alphen measurements on Pd-H alloys, with hydrogen concentrations up to 30 at% H in Pd. It is found that for H/Pd not greater than 0.06 the hydride remains in the alpha phase. The observed decrease in the area of various extremal cross sections of the d-hole ellipsoids at X and L is found to be due entirely to the lattice expansion caused by the interstitial hydrogen and not to the added hydrogen electrons. For H/Pd not less than 0.07 the alloy cannot be quenched in a metastable single phase state; this leads to a sharp drop in the Dingle temperature at H/Pd approximately equal to 0.07. Both the Dingle temperature and the dHvA frequencies remain approximately constant at higher hydrogen concentrations. B.J.

**A79-21687 Kinetics of hydrogen absorption and desorption.** T. B. Flanagan (Vermont, University, Burlington, Vt.). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 135-150. 40 refs. NSF-supported research.

Possible slow steps for hydrogen absorption (desorption) by metals, alloys and intermetallics are considered. The sequence of steps for hydrogen solution are: mass transport of  $\text{H}_2$ , dissociative chemisorption, surface migration, the transition from the chemisorbed to absorbed state, and bulk diffusion. When two solid phases coexist, the hydride phase transformation must appear in the sequence of steps. It is assumed that reaction occurs under isothermal conditions so that heat transfer can be neglected. For samples in the form of sheets, wires, etc., the slow step is often surface-control but for dispersed samples, such as activated intermetallics, where the rates may be extremely rapid, consideration must be given to mass transport control. The kinetics of hydrogen

absorption (desorption) by activated LaNi<sub>5</sub> are used to illustrate some of these considerations. (Author)

**A79-21688** The storage and release of hydrogen from magnesium alloy hydrides for vehicular applications. D. L. Douglass (California, University, Los Angeles, Calif.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 151-184. 8 refs. Contract No. E(04-3)-34-PA-236.

The optimum hydride for onboard vehicular storage of hydrogen depends on various parameters, such as rapid discharge kinetics at a temperature low enough to use exhaust-gas waste heat (about 220-250 C), a high hydrogen density to minimize the carrier weight, and resistance to fragmentation. Magnesium alloys exhibit some outstanding features but are deficient in other features. The present research program involved the study of numerous alloying additions, single-phase versus two-phase alloys, and binary versus ternary alloys in order to find the optimum alloy for hydrogen storage. The best alloy studied was the ternary Mg-5Ni-5Y which released over 3% hydrogen in 4 hours at 250 C. This alloy came the closest to fulfilling the program objectives and is a viable storage medium for vehicular applications. B.J.

**A79-21689** High temperature thermodynamics of the solid solutions of hydrogen and deuterium in palladium and in the Pd/0.9/Ag/0.1/ alloy. G. Boureau and O. J. Kleppa (Chicago, University, Chicago, Ill.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 185-191. 35 refs. NSF Grant No. DMR-75-08175.

**A79-21690** Calculated heats of formation of metal and metal alloy hydrides. C. D. Gelatt (Harvard University, Cambridge, Mass.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 193-204. 25 refs. NSF Grants No. DMR-72-02977; No. DMR-76-01111.

The basic features of the electronic structure of transition metal hydrides are understood. Results of the first ab initio calculation of the trends of the heat of formation of transition metal hydrides are discussed, and the basic one-electron energy difference technique is extended to consider the heat of formation of TiFeH<sub>2</sub> and TiPdH<sub>2</sub>. The present calculational method may be useful in suggesting practical hydrogen storage media, but the accuracy is not sufficiently high that one can quantitatively predict the heat of formation. For more precise results it will be necessary to carry out calculations which include the effects of charge self-consistency, which are treated in the present method by perturbation theory. (Author)

**A79-21691** Acoustic emissions during hydride formation. C. J. M. Northrup, W. J. Kass, and A. G. Beattie (Sandia Laboratories, Albuquerque, N. Mex.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 205-216. 15 refs. ERDA-supported research.

When a metal or alloy forms a hydride, the phase change is usually accompanied by the release of acoustic energy. The density changes that accompany hydride formation may also produce cracking and flaking. The acoustic emission accompanying these processes has been used to follow hydriding reactions and the technique has proven to be sensitive in the detection of boundaries on phase diagrams. Acoustic emission has been used to survey the hydriding properties of a number of alloys and metals (FeTi, LaNi<sub>5</sub>, UAl<sub>2</sub>, and Nb). This technique has proven useful as a method for monitoring particle breakup and for identifying laboratory procedures necessary to activate the hydride. (Author)

**A79-21692** Magnetic and electrical properties of rare earth and rare earth intermetallic hydrides. W. E. Wallace (Pittsburgh,

University, Pittsburgh, Pa.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 217-233. 42 refs. Army-supported research.

The rare earths and chemically related Y and Sc have a strong affinity for hydrogen. This affinity carries over to rare earth intermetallic compounds and is responsible for their exceptional capacity to store hydrogen. The present paper examines the electrical conductivity and magnetic behavior of rare earth hydrides. This examination is used to draw conclusions about the nature of hydrogen in such materials and about the mechanism by which the rare earths interact magnetically in the elemental state. In addition, the influence of hydrogenation on the magnetic behavior of a few selected intermetallics (e.g., GdNi<sub>2</sub>, Y<sub>6</sub>Mn<sub>23</sub> and Th<sub>6</sub>Mn<sub>23</sub>) is presented. B.J.

**A79-21693** Hydrogen absorption in rare earth intermetallic compounds. K. H. J. Buschow and A. R. Miedema (Philips' Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 235-249.

27 refs.

The paper examines various rare earth intermetallic compounds which are capable of adsorbing large quantities of hydrogen. Experimental data are discussed in relation to a model which predicts hydrogen adsorption behavior on the basis of stabilities of uncharged intermetallic compounds and corresponding binary rare earth hydrides. Experimental results show that hydrogen adsorption sometimes leads to phase separation or microprecipitation of the binary hydride. The importance of this effect in applications involving continuous H<sub>2</sub> adsorption and desorption cycles is discussed. B.J.

**A79-21694** Some applications of LaNi<sub>5</sub>-type hydrides. H. H. van Mal and A. R. Miedema (Philips' Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 251-260. 6 refs.

One consequence of a model for predicting the enthalpy of formation of ternary hydrides is that special compounds that suit the requirements set by a particular technical application can be prepared. The usefulness of metal hydrides in a number of small-scale applications (i.e., other than as a mass storage or transport medium for hydrogen) has already been demonstrated. The present paper discusses in detail such small-scale applications of ternary hydrides (particularly LaNi<sub>5</sub> hydride) in a thermally driven heat pump and a thermal compressor for hydrogen gas. B.J.

**A79-21695** Metal hydride electrodes for electrochemical energy storage. M. H. J. van Rijswijk (Philips' Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 261-271. 13 refs.

The paper discusses the characteristic features of hydrogen-absorbing alloys suitable as electrodes in aqueous solutions for the combined evolution, storage, and oxidation of hydrogen. The choice of intermetallics appears to be confined to those in which the major component is thermodynamically stable against oxidation in the hydrogen potential range (i.e., Ni and the noble metals). The capacity of known metal hydride electrodes (LaNi<sub>5</sub>, LaNi<sub>4</sub>Cu, and LaNi<sub>4</sub>Cr) at various temperatures is compared to that of other storage electrodes. It is found that for small particles charge transfer is the main rate-determining step, while for large particles hydrogen transport is the main rate-determining step. B.J.

**A79-21697** **Hydrides of rare earth-nickel compounds - Structure and formation enthalpies.** G. Busch, L. Schlapbach, and T. von Waldkirch (Eidgenössische Technische Hochschule, Zurich, Switzerland). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 287-292. 13 refs.

Investigations on the hydriding characteristics of La<sub>7</sub>Ni<sub>3</sub>, LaNi and Ce<sub>7</sub>Ni<sub>3</sub> show that these compounds readily absorb hydrogen up to compositions of La<sub>7</sub>Ni<sub>3</sub>H<sub>19.3</sub>, LaNiH<sub>3.85</sub> and Ce<sub>7</sub>Ni<sub>3</sub>H<sub>19.2</sub>. From structural and magnetic investigations La<sub>7</sub>Ni<sub>3</sub> is found to decompose into LaH<sub>3</sub> and LaNi<sub>5</sub> on hydrogenation. On desorption at elevated temperatures the original structure is reformed. The enthalpies of formation  $\Delta_f H$  have been measured for the La-Ni compounds.  $\Delta_f H$  varies linearly with the La-Ni-composition over the full range 100% La to 100% Ni. This, together with the linear dependence of the hydrogen to metal ratio versus composition shows that the hydrogen uptake of La-Ni-compounds is mainly determined by the enthalpies of formation rather than by the structure. (Author)

**A79-21698** **The plateau pressure of RE Ni<sub>5</sub> and RE Co<sub>5</sub> hydrides.** G. Busch, L. Schlapbach, and A. Seiler (Eidgenössische Technische Hochschule, Zurich, Switzerland). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 293-299. 10 refs.

RENi<sub>5</sub> and ReCo<sub>5</sub> compounds (RE stands for rare-earth metal) are known to absorb hydrogen, however, the quantity of hydrogen and the plateau pressure required for hydride formation are not known. In the present paper it is shown that, in the first approximation, the plateau pressure varies exponentially with the unit cell volume of the unhydrated compound. The plateau pressure of other series of hydrides of intermetallic compounds can be described by the same law, substituting the proper values of the constants. This law, however, does not describe all the aspects of the problem. The plateau pressure cannot be explained by geometrical considerations alone. V.P.

**A79-21699** **Synthesis and properties of useful metal hydrides - A review of recent work at Brookhaven National Laboratory.** J. J. Reilly (Brookhaven National Laboratory, Upton, N.Y.). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 301-322. 22 refs. Contract No. EY-76-C-02-0016.

Intermetallic hydride properties and the application of intermetallic compounds to the storage of hydrogen are discussed. Systems considered include Mg-Cu alloys, Mg-Ni alloys, iron-titanium alloys, and Ti-Cr alloys. Predictive criteria are presented for selecting intermetallic compounds likely to form hydrides and ascertaining certain properties of the hydrides. M.L.

**A79-21700** **The use of FeTi-hydride for production and storage of suprapure hydrogen.** H. Wenzl and K. H. Klatt (Kernforschungsanlage Jülich GmbH, Institut für Festkörperforschung, Jülich, West Germany). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 323-327. 6 refs.

**A79-21701** **Hydride formation of C14-type Ti alloy.** Y. Machida, T. Yamada, and M. Asanuma (Matsushita Research Institute Tokyo, Inc., Kawasaki, Japan). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 329-336. 9 refs.

The paper describes the hydriding properties of the TiCr<sub>2</sub>-based C14-type quaternary alloy system Ti(1-x)Zr(x)Cr(2-y)Mn(y) with x in the 0-0.5 range and y in the 0-2 range. The P-X-T method was used to determine some thermodynamic parameters. The Zr content was found to be influenced by the plateau pressure. An increase in Mn content leads to an increase in the plateau region, although the dissociation pressure does not change significantly. Stability of the quaternary hydride was explained qualitatively by means of the model proposed by Miedema et al. (1975). M.L.

**A79-21702** **Hydrogen sorption properties in binary and pseudobinary intermetallic compounds.** J. Shinar, I. Jacob, D. Shaltiel (Jerusalem, Hebrew University, Jerusalem, Israel), and D. Davidov (Jerusalem, Hebrew University, Jerusalem, Israel; Campinas, Universidade Estadual, Campinas, São Paulo, Brazil). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 337-352. 15 refs. Research supported by the National Council of Research and Development of Israel, Kernforschungsanlage Jülich, and Conselho Nacional de Pesquisas.

Particular attention is given to the systems: TiFe(0.8)X(0.2) where X = Mn, Cr, V, Co, Ni, Cu; LaNi<sub>5</sub>(5-x)Cu(x) where x is in the range 1-4; and Zr/A(x)B(1-x)/2 where x is in the range 0-1, A = V, Cr, Mn, and B = Fe, Co. The observation of plateaus in the dissociation isotherms of some of the hydrides of these intermetallic compounds enables the extraction of the hydride's heat of formation. It is found that the heats of formation do not always satisfy the rule of reverse stability. An alternative preliminary model is suggested to account for relative changes of heats of formation. The model takes into consideration the various interstitial sites occupied by the hydrogen atoms and gives information about the minimum configurational energy for the hydrogen in various sites. B.J.

**A79-21703** **The metallurgy and production of rechargeable hydrides.** G. D. Sandrock (International Nickel Research and Development Center, Suffern, N.Y.). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 353-393. 20 refs. Research supported by the International Nickel Co. and ERDA.

The hydrogen storage properties of metal alloy hydrides are intimately related to the metallurgy and microstructures of those alloys. The understanding of the metallurgy then becomes an important consideration in the practical production of a given alloy for hydrogen storage applications. Using FeTi and nickel-mischmetal-calcium as representatives of AB and AB<sub>5</sub> compounds, respectively, interrelations among composition, alloy microstructure, and hydrogen storage properties are presented in relation to large scale melting considerations. (Author)

**A79-21704** **A new rationale for the hysteresis effects observed in metal-hydrogen systems.** C. E. Lundin and F. E. Lynch (Denver, University, Denver, Colo.). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 395-405. 20 refs. ARPA Order 2552.

Recent interest in metal-hydrogen systems has been intensified by the potential of certain types of hydrides to store hydrogen for energy purposes. However, the observed hysteresis results in a reduced thermodynamic efficiency in various applications of metal-hydrogen systems. In this paper, a general theory based on a model of induced lattice strains during hydrogen adsorption and its relief on desorption is proposed to account for hysteresis effects observed in metal-hydrogen systems. Earlier theories are based on macroscopic effects, but the new rationale relies on an atomistic model. It focuses on the effect of hydrogen atoms occluded in the interstitial sites in the metal lattice and the resulting strains imposed. It is shown that the strain characteristics of the class of metal-hydrogen compounds for energy storage purposes contribute significantly to hysteresis effects, and that the thermodynamic stability of the hydride correlates with the interstitial hole size of the atomic lattice. S.D.

**A79-21706 Heat transfer characteristics of porous metallic matrix metal-hydrides.** M. Ron and M. Elemelach (Technion - Israel Institute of Technology, Haifa, Israel). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 417-430. 24 refs.

Metal hydrides (MH) consolidated into a highly porous metallic matrix have been suggested as a way to overcome the problem of the poor heat transfer response of a powder bed and to provide a more efficient and simple hydrogen storage device. The utilization of the porous matrix is particularly important for MH systems with relatively high heat of formation, and ultimate hydrogen content, such as magnesium and magnesium alloy hydrides. The use of the porous matrix makes it possible to design a considerable area of heat contact between the surface of the energy conversion device and the porous matrix.

B.J.

**A79-21707 The effect of induced disorder on the hydrogenation behaviour of the phase ZrCo.** S. J. C. Irvine and I. R. Harris (Birmingham University, Birmingham, England). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 431-446. 12 refs. Research supported by the Science Research Council.

The paper reports on P-C-T, X-ray diffraction, and magnetic measurements on the ZrCo-H system. Hydrogenation of ZrCo occurs readily at 473 K and at a hydrogen pressure as low as 200 torr. The hydriding isotherms indicate an extensive solid solution region based on the bcc phase up to about 0.35 H/M for the 573 K isotherm. In the pressure range 0.2 torr to 590 torr and temperature range 423-773 K there are three phases: the initial alpha phase based on the CsCl structure and the two hydride phases. The lower hydrogen concentration phase is evidently formed by a peritectoid reaction. X-ray diffraction data indicate a highly strained lattice for the hydride phases, and the reaction measurements on the bcc phase after cycling across the alpha phase boundary and then outgassing at 423 K indicate a significantly disordered CsCl lattice which is a reflection of the disorder within the hydride phases. The disordering effect results in the appearance of a field dependent contribution to the magnetic susceptibility, indicating ferromagnetic ordering. P.T.H.

**A79-21709 Electrochemical utilization of metal hydrides.** K. Videm (Institutt for Atomenergi, Kjeller, Norway). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 463-477. 14 refs.

The paper briefly describes materials and electrochemical cells for the utilization of metal hydrides and discusses the potential of hydride electrochemical systems. Emphasis is on cells that are based on reactions with hydrogen without handling hydrogen in gaseous form. A system for supplying a house with heat and electric power is shown, consisting of an electrochemical cell with a metal hydride anode and an oxygen electrode for current generation. A hydrogen-hydride-air storage battery is also schematized, which can be charged and discharged as a normal secondary cell, but which has the advantage of also being chargeable with hydrogen gas. Data on the energy per unit weight of some reactions of interest for electrochemical current generation are presented. The required properties for materials of hydrogen electrodes are examined, and the state of the search for such materials is reviewed.

P.T.H.

**A79-21710 Hydrogen storage electrode systems.** F. A. Lewis (Belfast Queen's University, Belfast, Northern Ireland). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 479-484. 58 refs.

Hydrogen storage is considered with reference to application of metals which readily permit diffusion of hydrogen. Substantial hydrogen gas pressures can be developed inside hollow tubes by electrolytically discharging hydrogen on their outer surfaces, and intratube absorption of hydrogen by metals or intermetallic com-

pounds would permit removal of hydrogen in a discharge cycle at a relatively fixed electrode potential. Hollow electrode systems, the choice of tube metal, and possibilities of isotope separation are discussed.

M.L.

**A79-21711 Hydrogen electrochemical storage by substituted LaNi<sub>5</sub> compounds.** A. Percheron-Guegan, J. C. Achard (CNRS, Laboratoire de Chimie Métallurgique et Spectroscopie des Terres Rares, Meudon, Hauts-de-Seine, France), J. Sardin, and G. Bronel (Ecole Nationale Supérieure d'Electrochimie et d'Electrométallurgie, Saint-Martin-d'Hères, Isère, France). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 485-490. 8 refs.

An attempt is made to report on experiments in which hydrides were obtained from intermetallic compounds consisting of Ni, La, and one other element (Cu, Cr, Al, or Mn). Attention is given to the effects of substitution on hydride stability and capacity, as well as to the electrochemical capacity of the hydrides at room temperature and 40 C. The use of the studied compounds as hydrogen storage electrodes is considered to be very attractive. It is noted that some of these compounds have been fabricated into compact industrial electrodes with a capacity higher than 300 mAh/g between -10 and plus 50 C.

F.G.M.

**A79-21713 Rare earth and actinide intermetallics as hydrogenation catalysts.** W. E. Wallace (Pittsburgh University, Pittsburgh, Pa.). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 501-514. 14 refs. Research supported by the Pennsylvania Science and Engineering Foundation and NSF.

Rare earth intermetallics and certain actinide intermetallics have been found to be catalytically active for the formation of methane from CO and H<sub>2</sub>; the rare earth intermetallics have also been found to be active as synthetic ammonia catalysts. The present paper describes the investigation of such catalysts by means of surface energy determinations, X-ray diffraction, SEM, energy dispersive analysis by X-rays, and AES. These studies indicate that the original intermetallic has been transformed during reaction into a substrate of rare earth or actinide oxides supporting nodules (about 0.5 microns in diameter) of the transition element, these nodules assumed to be the active catalysts.

B.J.

**A79-21714 Mixing effects of two different types of hydrides.** S. Suda and M. Uchida (Kogakuin University, Tokyo, Japan). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 515-525. 9 refs.

A method is proposed for modifying and controlling the P-T-x relations as well as the plateau shapes of known hydrides through a simple combination of two different kinds of hydriding compounds. Two mixtures of LaNi<sub>5</sub> + TiFe and LaNi<sub>5</sub> + Ti(0.8)Zr(0.2)Cr(0.8)Mn(1.2) were selected to illustrate the present method and the equilibrium pressure and composition relations for a series of mixtures were measured under three isothermal conditions of 30, 40, and 50 C, respectively. No interaction between the two constituents was observed through 100 cycles of sorption-desorption.

B.J.

**A79-21715 Applications of metal hydrides.** J. J. Reilly (Brookhaven National Laboratory, Upton, N.Y.). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 527-550. 28 refs. Contract No. EY-76-C-02-0016.

Some criteria which a metal hydride must satisfy to serve as a practical energy or hydrogen storage medium are examined. The most important of these criteria is that the metal hydride be easily

formed and decomposed. A further important criterion is the heat of decomposition, which even in the case of unstable hydrides is substantial.

V.P.

**A79-21716 HYCSOS - A system for evaluation of hydrides as chemical heat pumps.** I. Sheft, D. M. Gruen, G. J. Laimich, L. W. Carlson, A. E. Knox, J. M. Nixon, and M. H. Mendelsohn (Argonne National Laboratory, Argonne, Ill.). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977.* Oxford, Pergamon Press, Ltd., 1978, p. 551-567. 5 refs.

The Argonne HYCSOS system is a two hydride concept, operating as a chemical heat pump for storage and recovery of thermal energy for heating, cooling and energy conversion. Hydrogen gas is transferred from one hydride bed by thermal energy input at a characteristic temperature to a second bed where the hydrogen is absorbed and thermal energy is released at another characteristic temperature. The demonstration unit has four steel tanks of approximately 3 liters free volume each for holding the hydride and is fully instrumented to measure and record system characteristics on a data logger. Remotely valved fluid heat transfer loops are available. Sub-micron steel filters are installed above each tank to retain the alloy particles in the tanks. The thermal energy input is simulated by an 18 KW electric heater. The unit described is an experimental facility of sufficient size to be able to demonstrate the feasibility of heat transfer processes.

(Author)

**A79-21717 The hydrogen/hydride energy concept.** H. Buchner (Daimler-Benz AG, Stuttgart, West Germany). In: *Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977.* Oxford, Pergamon Press, Ltd., 1978, p. 569-599. 21 refs.

The paper reviews the hydride energy concept, discusses several applications of the concept in energy systems, and discusses some of the materials science aspects of the problem of hydride energy. Test data on automotive vehicles with hydride experimental engines are presented. A hydride air conditioning system is described. Some systems for hydride systems for waste heat storage are presented. The fundamentals of hydrogen/deuterium dissociation when Ti-Ni alloys are used are reviewed.

P.T.H.

**A79-21807 \* Effect of grain boundaries in silicon on minority-carrier diffusion length and solar-cell efficiency.** T. Daud, K. M. Koliwad (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.), and F. G. Allen (California, University, Los Angeles, Calif.). *Applied Physics Letters*, vol. 33, Dec. 15, 1978, p. 1009-1011. Contract No. NAS7-100.

The spatial variation of minority-carrier diffusion length in the vicinity of a grain boundary for a polycrystalline silicon sheet has been measured by the use of the EBIC technique. The effect of such a variation on solar-cell output has then been computed as a function of grain size. Calculations show that the cell output drops considerably for grain size smaller than three times the bulk diffusion length.

(Author)

**A79-21825 Geothermal energy: Its past, present and future contributions to the energy needs of man.** H. C. H. Armstead. London, E. & F.N. Spon, Ltd.; New York, Halsted Press, 1978. 382 p. 200 refs. \$27.50.

Procedures for obtaining and applying energy from geothermal fields are examined. Topics considered include exploration, drilling, bore characteristics and their measurement, fluid collection and transmission, electric power generation from geothermal energy, geothermal space heating, domestic hot water supplies, and air conditioning. Geothermal field geology, dual and multipurpose projects, the control and safety of geothermal installations, economic considerations, chemical and metallurgical problems, environmental problems, and future prospects are discussed.

M.L.

**A79-22099 Materials for low-cost solar cells.** F. A. Shirland and P. Rai-Choudhury (Westinghouse Research and Develop-

ment Center, Pittsburgh, Pa.). *Reports on Progress in Physics*, vol. 41, Dec. 1978, p. 1839-1879. 55 refs.

Photovoltaic materials are reviewed with regard to their possible use in systems that could provide very large amounts of electric power from the sun before the end of the century. The key is taken to be the cost of the solar cells which are considered to be presently about two orders of magnitude too high. Only silicon, in single crystal or ribbon form, or CdS in thin-film form are thought to be sufficiently developed to permit their possible large-scale exploitation by the last decade of the century. Silicon is considered to have the advantage over CdS at present for large-scale use because of the higher performance levels and the broader existing technology base. CdS thin films are considered to have greater potential if selected improvements can be effected in design and performance, because of lower projected cost and the ease of automating manufacture.

(Author)

**A79-22223 The oscillating water column wave-energy device.** D. V. Evans (Bristol, University, Bristol, England). *Institute of Mathematics and Its Applications, Journal*, vol. 22, Dec. 1978, p. 423-433. 7 refs.

An expression is obtained for the efficiency of wave-energy absorption of a float connected to a spring-dashpot system on the top of a column of fluid bounded by two closely-spaced vertical parallel plates or a narrow tube immersed under waves. The method makes extensive use of the approximate solution using matched asymptotic expansions obtained by Newman (1974) to the corresponding problem when the float-spring-dashpot system was absent. It is shown that for plates of equal length the maximum possible efficiency is 50%, and that for the three-dimensional case it is theoretically possible to capture the energy in a wave whose crest length is greater than the tube diameter.

(Author)

**A79-22236 The synergetics of the catalytic D-D-fusion-fission breeder.** K. F. Schoepf (McMaster University, Hamilton, Ontario, Canada; Innsbruck, Universität, Innsbruck, Austria) and A. A. Harms (McMaster University, Hamilton, Ontario, Canada). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 5-19. 16 refs. Research supported by the National Research Council of Canada.

A parametric assessment of the D-D-fuelled fusion-fission hybrid reactor is undertaken. Based on the fusion hybrid reactor characteristic that the attainment of a 'break-even' plasma is not essential for the maintenance of a viable system, its capabilities of net power generation and fissile fuel production at low plasma fusion gains are investigated in this paper. Analysis of the isotopic and energetic balances under steady-state conditions has resulted in the formulation of essential relationships involving fissile fuel yield, system power, fusion plasma efficiency, and plutonium content in the blanket material. The increasing systems design flexibility associated with the catalysed-D hybrid reactor suggest the definite possibility of an earlier introduction of advanced fusion cycles in the production of nuclear energy.

(Author)

**A79-22237 Minimum-average-B wells in linked magnetic mirror fields.** J. C. Riordan, A. J. Lichtenberg, and M. A. Lieberman (California, University, Berkeley, Calif.). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 21-31. 14 refs. NSF Grant No. ENG-75-02709; Contract No. E(04-3)-3-PA-215.

Minimum-average-B wells are examined for use in hydromagnetically stable linked mirror traps. A multipole expansion to fourth order in radius is used. The magnetic field shapes are chosen by a combination of heuristic and variational techniques to optimize the well radius. Numerical results show that the optimized wells are more practical than was previously realized, and that the required field shapes can be achieved with a simple coil configuration.

(Author)

**A79-22238 Measurements of plasma rotation in tokamak LT-3.** M. G. Bell (Australian National University, Canberra, Australia). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 33-38. 20 refs.

Rotation of the plasma in LT-3 has been measured from the Doppler shift of lines emitted by ionized oxygen impurities. In stable discharges, toroidal rotation of the ions in the direction of the discharge current was measured at velocities of up to 5 km/s, while poloidal rotation was observed in the electron diamagnetic drift direction, reaching linear velocities of 1.6 km/s at a minor radius of 5 cm. In unstable discharges, the plasma rotation collapses at the disruptions and then reappears as the magnetic surfaces are reformed. (Author)

**A79-22239** Particle orbits in field-reversed mirrors. M. Y. Wang and G. H. Miley (Illinois, University, Urbana, Ill.). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 39-49. 18 refs. Research supported by the U.S. Department of Energy.

The particle orbits in field-reversed mirrors (FRM) are studied. It is found that the orbit can be expressed in terms of the first and third kind of elliptic integral for particles moving in the centre plane of the Hill vortex configuration. Requirements for absolute confinement are obtained, and four distinct classes of orbits are identified that are bounded by limits on the canonical angular momentum. The improvement in confinement over a simple mirror as well as natural divertor properties of the FRM are illustrated by these results.

(Author)

**A79-22240** Empirical scaling laws for energy confinement in ohmically-heated tokamaks. W. Pfeiffer and R. E. Waltz (General Atomic Co., San Diego, Calif.). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 51-67. 43 refs. Contract No. EY-76-C-03-0167.

Differences among the empirical scaling laws proposed for tokamak energy confinement are clarified, and the various scaling laws are reconciled, insofar as is possible. The energy confinement and replacement times are defined, scaling laws and their interpretation are discussed, and emphasis is placed on the limitation imposed by ohmic heating as well as on the need for information about the temperature dependence of confinement time. A compilation of over 100 data points (discharges) is provided, along with a basis for their selection and histograms of scaling variables. Linear regression analysis is used to determine scaling laws from the data, a temperature scaling law describing the entire data base is given, and its faithfulness as a general representation is tested by fits to data subsets. Confinement-time scalings are also presented, and one that is temperature independent is compared with previously proposed scalings. F.G.M.

**A79-22241** An overview of design space for small fusion targets. R. C. Kirkpatrick (California, University, Los Alamos, N. Mex.). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 69-79. 7 refs.

A twelve-parameter burn code has been used to gain an overview of the design space available for laser and E-beam fusion targets. The results of a few thousand implosion calculations are presented in terms of an initial-condition space. The initial conditions include temperature, density, and pusher jump-off velocity. For marginal driving energy there is an isolated region in the initial-condition space (temperature, density) for which ignition may be achieved. (Author)

**A79-22242** Space-dependent thermal stability of reacting tokamak plasmas. W. A. Houlberg and R. W. Conn (Wisconsin, University, Madison, Wis.). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 81-92. 21 refs. Research supported by the Wisconsin Electric Utilities Research Foundation; Contract No. ET-76-S-02-2272.

A technique is presented for the analysis of thermal stability in reacting tokamak plasmas using a one-dimensional time-dependent fluid-transport model. Application is made to the analysis of density-related thermal instabilities in a neutral-beam-driven two-component plasma (TETR) and a conceptual reactor-size ignited plasma (UWMAK-III). A density-driven thermal instability can exist when the particle confinement varies as particle density. This condition is satisfied by the trapped-ion-mode diffusion model and an empirical model. A time delay in the heating due to finite alpha thermalization does not significantly alter the character of the instability at normal plasma densities. A linear feedback response for

the particle source is found to provide a stabilized equilibrium in all cases. Strong radial variation of the transport and physical properties of the plasma is found not to introduce radial-dependent feedback requirements. Feedback on the average density is sufficient for stabilization with moderate response times. (Author)

**A79-22243** Alpha transport and blistering in tokamaks. W. Bauer, K. L. Wilson, C. L. Bisson, L. G. Hagmark (Sandia Laboratories, Livermore, Calif.), and R. J. Goldston (Princeton University, Princeton, N.J.). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 93-103. 34 refs. Research supported by the U.S. Department of Energy.

The particle flux and angular distribution of 3.5 MeV alpha particles impinging on the first wall from uncontrolled banana orbits in an axisymmetric tokamak reactor have been calculated. The resulting helium concentration profiles in the first wall can give rise to surface exfoliation under specified conditions. The major mitigating factor is the simultaneous surface recession due to sputtering by the D-T charge-exchange neutral flux. For the parameters used in these calculations blistering in high-sputtering-rate materials such as beryllium is unlikely, whereas in low-sputtering-rate materials such as niobium helium-induced surface deformation is quite probable.

(Author)

**A79-22244** Local theory of finite-beta, collisional drift modes. R. R. Dominguez (California, University, Berkeley, Calif.). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 105-107. NSF Grant No. ENG-75-02709; Contract No. E(04-3)-34-PA-215.

The stability of the collisional drift-Alfvén mode in a shearless magnetic field is investigated in the local approximation. In the absence of temperature gradients, it is shown that the beta-threshold for stability in a collisional finite-beta plasma is essentially the same as the collisionless results, beta greater than 0.15. (Author)

**A79-22265** Investigations of solar heat production for household heating in Turkey (Travaux de production de chaleur solaire pour le chauffage d'habitat en Turquie). M. Babayigit (Mineral Research and Exploration Institute of Turkey, Ankara, Turkey). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 7-11. 7 refs. In French.

A Turkish research program on the use of solar energy for household heating is surveyed. The research, conducted at Marmaris, is concerned with the use of a passive method, the Trombe wall. Insolation data; energy production, consumption, and cost data; and calculations and parameters concerning the physics of household heating are presented. The order of priority for supplying heat to different classes of dwellings is reported. M.L.

**A79-22266** Calculation of solar energy incident on non-horizontal surfaces over Turkey. E. Tasdemiroglu, F. Ramos Berjano, and D. Tinaut (Mineral Research and Exploration Institute of Turkey, Ankara, Turkey; Consejo Superior de Investigaciones Científicas, Madrid, Spain). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 12-15.

The daily total, direct, and diffuse radiation received by southwardly inclined surfaces (0 to 90 deg) at the latitude of Ankara (approximately 40 deg) is calculated by applying the Liu and Jordan relations to data on radiation received by horizontal surfaces at 43 stations. Values of radiation received hourly by a surface inclined 30 deg at Ankara are provided for each month. The computer program sequence of parameter determinations is indicated. M.L.

**A79-22267** Solar energy diagrams (Les diagrammes solaires énergétiques). J.-L. Izard (Aix-Marseille I, Université, Marseille, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 16-20. 12 refs. In French.

Visibility and isoincidence curves for planes inclined 15 to 90 deg and oriented 50 to 85 deg with respect to the sun are presented.

**A79-22268**

It is intended that this information on solar radiation be applied by architects who wish to determine the effects of architectural (for example, shadowing) features on the solar energy received by the glass surfaces of a house. Parameters for different glass structures and procedures for calculating direct, diffuse, and reflected radiation are presented.

M.L.

**A79-22268 Solar heating using a heat pump and cold collectors (Chauffage solaire utilisant une pompe à chaleur et des capteurs froids).** A. Cordier and G. Gessinn (Toulouse III, Université, Toulouse, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 21-26. 8 refs. In French.

A solar heating system which uses flat-plate collectors kept at 0°C is described, and a simulation study to determine optimum operating conditions for the system is reported. The heat pump, storage system, evaporators, and various collectors are characterized, and the functioning of the system with alternative components is examined, with attention to potential problems caused by a build-up of freon vapor pressure and by water condensation on the cold collectors. The energy output of the system is calculated for some operating conditions.

M.L.

**A79-22269 Solar thermal conversion installations in the medium power range - The Thek project (Unités de conversion héliothermique dans la gamme des moyennes puissances, le projet 'Thek').** G. Peri, J. Desautel, B. Imbert, M. Audibert, R. Pasquetti, and J.-P. Batistelli (Aix-Marseille I, Université, Marseille, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 27-31. In French.

The CNRS Thek project to develop central-focusing solar energy installations is discussed. Factors involved in the design of collector modules are examined with attention to the module shape, surface, absorption characteristics, mounting, and automatic tracking. A procedure for experimental testing is considered.

M.L.

**A79-22270 Storage efficiency in a solar plant (Rendement d'un stock dans une installation solaire).** L. Keller. *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 35-37. In French.

Energy storage procedures for solar plants are analyzed and compared, and it is concluded that storage involving latent heat is slightly more advantageous than storage involving sensible heat, and that both storage procedures are preferable to storage that involves reaction heat. The analysis assumes that a precise storage temperature can be maintained. Some numerical calculations of the storage efficiency are presented.

M.L.

**A79-22271 A hybrid chemical concept for solar energy storage (Communication sur un concept chimique hybride pour le stockage de l'énergie solaire).** A.-C. Vialaron (CNRS, Institut du Génie Chimique, Toulouse, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 38-41. 5 refs. In French.

Solar energy storage procedures that merely involve storage of heat are compared with hybrid storage procedures that involve a chemical reaction as well as thermal storage. A sulfur dioxide and magnesium oxide system that utilizes the dissociation of water (hydrogen production) is described, and two scenarios for application of this system are considered. The system capabilities and requirements are examined.

M.L.

**A79-22272 Storage tank efficiency as simulated in a Markovian model of meteorology.** R. Lestienne (CNRS, Paris, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 42-45.

The storage efficiency of a solar energy production-storage system with randomly varying daily energy production is characterized in terms of a Markov model. Sunshine duration and production probability densities for 'good' and 'bad' days are considered in this

procedure. The storage efficiency for various meteorological conditions occurring in southern France is discussed.

M.L.

**A79-22273 Electrochemical use of biomass (Utilisations électrochimiques de la biomasse).** I. Gillet (Liège, Université, Liège, Belgium). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 46-50. In French.

Electrochemical oxidation studies of glucose and glycerine, which are substances derived from plant biomass, are reported. It is suggested that these substances serve as solar energy storage systems. The results of preliminary experiments are considered with reference to the determination of parameters that would enable the design of solar energy storage systems which use substances obtained from plant biomass.

M.L.

**A79-22274 Industrial aspects in solar energy instruction (Aspect industriel dans l'enseignement de l'héliotechnique).** M. Touchais (Le Mireio, Salon-de-Provence, Bouches-du-Rhône, France). (*Coopération Méditerranéenne pour l'Energie Solaire, Rencontre Internationale*, 17th, Hamburg, West Germany, July 13, 1978.) *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 51-55. In French.

Two introductory courses on solar energy are described. One course seeks to correct commonly held erroneous concepts concerning solar energy and to indicate areas requiring future research. The second course provides a technical analysis of collectors, thermal storage systems, and related equipment, and suggests ways of organizing solar energy system components for various applications.

M.L.

**A79-22280 Charge transfer by surface states in the photo-electrolysis of water using a semiconductor electrode.** M. Nishida (Kanazawa Institute of Technology, Nonoiichi, Japan). *Nature*, vol. 277, Jan. 18, 1979, p. 202, 203. 14 refs.

A theoretical treatment of electron tunneling between a semiconductor and an electrolyte via surface states is given. A theory of interface states in tunnel MOS devices is applied to the semiconductor-electrolyte interface. It is shown that a rather high efficiency for holes at the interface can be obtained when the electron population of surface states is controlled by the electrolyte and the surface states are almost completely occupied. The analysis is performed in the context of photolysis of water using n-TiO<sub>2</sub> semiconductors.

F.G.M.

**A79-22284 The Sunship.** G. Khouri (Imperial College of Science and Technology, London, England) and E. Mowforth (Surrey, University, Guildford, England). *Sunworld*, vol. 2, Nov. 1978, p. 92-94.

Development of a solar-powered airship - Sunship - is proposed for moving substantial payloads in areas where there is sufficient solar-energy intake. It is suggested that an airship with a conventional configuration and with an array of solar cells over the greater part of its skin area would be capable of carrying a working load of 3 to 5 tons. Geographic range of potential operation, present and future solar cell costs, and hull structure are considered.

M.L.

**A79-22285 Solar water heaters for a cold climate.** T. R. Shelley (Montana College of Mineral Science and Technology, Butte, Mont.). *Sunworld*, vol. 2, Nov. 1978, p. 112-116.

Solar water heating systems designed to operate at January temperatures (approximately -7 to -9°C) in Butte, Montana are described. The goal was to heat the water in a 150-liter domestic hot-water tank to 66°C, and various combinations of collectors, heat exchangers, and working fluids are studied. The single-glazed aluminum collector is found to be just as effective as copper or aluminum double-glazed collectors, while the heat exchanger using the coil of copper pipe on the outside is found to be suitable even though less efficient than the pipe in the oil drum. System construction costs are estimated.

M.L.

**A79-22338 # Influences on exhaust emissions from automotive gas turbines.** R. Buchheim (Volkswagenwerk AG, Wolfsburg, West Germany). (*American Society of Mechanical Engineers, Gas Turbine Conference, London, England, Apr. 9-13, 1978, Paper 78-GT-85.*) *ASME, Transactions, Journal of Engineering for Power*, vol. 101, Jan. 1979, p. 186-194. 16 refs. Research sponsored by the Bundesministerium für Forschung und Technologie.

Experimental and theoretical investigations on conventional diffusion flame type combustors and on premix/prevaporize combustors were performed. The range of pollutant levels attainable with the various types of combustors is analyzed. The effect of different fuel nozzles, various fuels, and gas turbine thermodynamic cycle data on exhaust emissions is shown. Correlations are developed as far as possible. (Author)

**A79-22365 \* Investigation of a staged plasma-focus apparatus.** J. H. Lee (Vanderbilt University, Nashville, Tenn.), D. R. McFarland (NASA, Langley Research Center, Hampton, Va.), and W. L. Harries (Old Dominion University, Norfolk, Va.). *Plasma Physics*, vol. 20, Oct. 1978, p. 1025-1038. 11 refs. Grants No. NSG-1235; No. NSG-1022.

A new staged plasma-focus geometry combining two Mather-type plasma-focus guns was constructed, and the current-sheet dynamics were investigated. The production of simultaneous pairs of plasma foci was achieved. The intensities of X-ray and fusion-neutron emission were measured and found to agree with the scaling law for a plasma focus. Advantages of this new geometry include the possibility of using plasma-focus type pinches in multiple arrays at power levels beyond the validity regime of the current scaling law for a single gun. (Author)

**A79-22369 Plasma density measurements on refueling by solid hydrogen pellets in a rotating plasma.** L. W. Jorgensen and A. H. Silleesen (EURATOM and Riso National Laboratory, Roskilde, Denmark). *Plasma Physics*, vol. 20, Oct. 1978, p. 1081-1086. 11 refs.

Experimental results are presented on the possibility of refueling future tokamak fusion reactors with frozen D-T pellets. Laser interferometry was used to directly measure the increase in plasma density caused by ablation of a solid hydrogen pellet situated in a rotating plasma. Nearly half of the pellet material evaporated and seemed to be completely ionized, resulting in an increase in the amount of plasma equivalent to one third of the total amount of plasma before refueling. The gross behavior of the plasma was unchanged. B.J.

**A79-22379 A simple neutral density profile calculation for tokamaks with lambda sub mfp much smaller than a.** R. J. Goldston (Princeton University, Princeton, N.J.). *Plasma Physics*, vol. 20, Nov. 1978, p. 1199-1203. 5 refs. Contract No. EY-76-C-02-3073.

A simple and expeditious technique is developed for calculating the neutral density profile in the dense region of large tokamak plasmas, where the mean free path is small in comparison to other macroscopic scales. The method rests on determining the local logarithmic derivative of the number of neutrals from a self-consistent calculation of the radial flux of neutrals, combined with a condition on the divergence of the neutral radial flux. The results from this simple technique are compared with a more time-consuming Monte-Carlo calculation, and good agreement is found. (Author)

**A79-22427 Wave reflection from the lower hybrid surface - A toroidal effect.** E. Ott, J.-M. Wersinger, and P. T. Bonoli (Cornell University, Ithaca, N.Y.). *Physics of Fluids*, vol. 22, Jan. 1979, p. 192, 193. 5 refs. Research supported by the U.S. Department of Energy.

An analysis is performed which demonstrates that the toroidal geometry of a cold plane-stratified toroidal equilibrium plasma leads to reflection of cold lower hybrid waves at the lower hybrid layer rather than resonance. This effect is attributed to the fact that the toroidal equilibrium magnetic field does not lie in the lower hybrid

surface. A numerical calculation of lower-hybrid-wave propagation in a specific model toroidal equilibrium is presented which shows that after the first few bounces of an externally launched cold lower hybrid wave off the lower hybrid surface, thermal effects come into play, and the wave will mode-convert to a hot plasma wave or be absorbed. It is noted that for a central temperature of 1 keV, mode conversion occurs before the wave has a chance to bounce. F.G.M.

**A79-22516 # Energy and remote sensing applications.** R. A. Summers (U.S. Department of Energy, Washington, D.C.), W. L. Smith (Spectral Data Corp., Arlington, Va.), and N. M. Short (NASA, Goddard Space Flight Center, Greenbelt, Md.). In: *International Symposium on Remote Sensing of Environment, 12th, Manila, Philippines, April 20-26, 1978, Proceedings. Volume 1.*

Ann Arbor, Mich., Environmental Research Institute of Michigan, 1978, p. 395-413. 27 refs.

The nature of the U.S. energy problem is examined. Based upon the best available estimates, it appears that demand for OPEC oil will exceed OPEC productive capacity in the early to mid-eighties. The upward pressure on world oil prices resulting from this supply/demand gap could have serious international consequences, both financial and in terms of foreign policy implementation. National Energy Plan objectives in response to this situation are discussed. Major strategies for achieving these objectives include a conversion of industry and utilities from oil and gas to coal and other abundant fuels. Remote sensing from aircraft and spacecraft could make significant contributions to the solution of energy problems in a number of ways, related to exploration of energy-related resources, the efficiency and safety of exploitation procedures, power plant siting, environmental monitoring and assessment, and the transportation infrastructure. G.R.

**A79-22522 # Remote sensing use in hydraulic planification in Mexico.** J. A. Díez Pérez (Comisión del Plan Nacional Hidráulico, Secretaría de Agricultura y Recursos Hídricos, Mexico City, Mexico). In: *International Symposium on Remote Sensing of Environment, 12th, Manila, Philippines, April 20-26, 1978, Proceedings. Volume 1.*

Ann Arbor, Mich., Environmental Research Institute of Michigan, 1978, p. 497-502.

Mexican participation in NASA Mission 91 projects is reviewed. The mission objectives are the detection of mineral deposits and geothermal zones, data collection for geohydrological studies, flood identification, and crop classification. Projects described include a water pollution study over Acapulco Bay, citrus inventory in the main orange-producing Mexican state of Nuevo Leon, a joint project with USDA to identify hosts of the Mediterranean fruit fly, and water-resource studies for an inland semiarid region, a coastal semiarid region, and a tropical jungle. The advantages of remote sensing as a useful planning tool for regional and national projects in underdeveloped countries are discussed. F.G.M.

**A79-22557 # Surtrace - An airborne geochemical system.** A. R. Barringer, J. H. Davies, and L. Daubner (Barringer Research, Ltd., Rexdale, Ontario, Canada). In: *International Symposium on Remote Sensing of Environment, 12th, Manila, Philippines, April 20-26, 1978, Proceedings. Volume 2.*

Ann Arbor, Mich., Environmental Research Institute of Michigan, 1978, p. 975-990.

The described Surtrace system obtains samples of the surface microlayer and, with the aid of the Lasertrace analytical system, determines ppm values for several elements. Airborne, vehicle-mounted, and man-portable versions of the device are designed to aid study of shallow and deep mineral deposits, geothermal regions, and hydrocarbon accumulations. Surface microlayer particulates are removed by application of a vacuum in a semicontinuous operation at flight speeds between 25 and 50 mph, and the sample particulates are affixed on adhesive tape. Examples of application of Surtrace to prospecting are presented. M.L.

## A79-22620

**A79-22620 # Infrared remote sensing on geothermal areas by helicopter.** M. Sekioka (Defense Academy, Yokosuka, Kanagawa, Japan) and K. Yuhara (Kyushu University, Fukuoka, Japan). In: International Symposium on Remote Sensing of Environment, 12th, Manila, Philippines, April 20-26, 1978, Proceedings. Volume 3.

Ann Arbor, Mich., Environmental Research Institute of Michigan, 1978, p. 1679-1686. 7 refs.

A technique is developed to determine surface temperature distributions by using a helicopter-borne infrared thermographic instrument giving thermal images of television type. Making a helicopter with an open hatch on its floor, through which thermal images are photographed, to hover over the target area, the temperature distributions with high resolution can be obtained in projection on a horizontal plane. Two experimental surveys were performed for several subregions of an active volcanic island. In the first survey, an attempt to print out digitally the ratio of areas between each adjacent isotherm on the isothermal image is carried out with an isothermal area processor. A method converting the isothermal pattern of geothermal fields to a distribution of heat discharge will be applied to such a ratio of areas of isothermal patterns thus obtained in the near future. In the second one, effects of atmospheric absorption and emission between the sensor of the thermocamera and the target area are evaluated using a newly developed helicopter-borne radiosonde system to correct the surface temperatures measured by the thermocamera.

(Author)

**A79-22756 The economics of geothermal energy development at the regional level.** A. Rose, S. Edmunds, and E. Lofting (California, University, Riverside, Calif.). *Journal of Energy and Development*, vol. 4, Autumn 1978, p. 126-152. 15 refs. NSF Grant No. AER-75-08793.

Regional economics of geothermal energy development are discussed with Imperial County, California as a case study. A multisector input-output analysis is outlined, together with the presentation of a simulated geothermal development scenario. Results of the methodology are given and interpreted, concluding that the impact of energy development on Imperial County will be significantly favorable, with the major points being employment, output and tax revenue incomes. Policies for increasing the net benefits of geothermal development are analyzed with consideration to such possible problems as appreciation of land value, environmental effects, interregional equity, and depletion of geothermal resources. It is noted that the major conclusions are not affected by alternative development scenarios within a broad technically feasible, and economically viable range.

A.A.

**A79-22760 Energy for the long run - Fission or fusion.** G. L. Kulcinski (Wisconsin, University, Madison, Wis.), G. Kessler (Gesellschaft für Kernforschung mbH, Karlsruhe, West Germany), J. Holdren (California, University, Berkeley, Calif.), and W. Häfele (International Institute for Applied Systems Analysis, Laxenburg, Austria). *American Scientist*, vol. 67, Jan.-Feb. 1979, p. 78-89. 13 refs.

Fusion and fast-breeder fission energies are analyzed in terms of problems and potentials. The status of fission and fusion systems is described, taking into account three thresholds of feasibility: scientific, engineering, and commercial. Degradation of materials due to radiation damage in the reactor environment is considered, as is the potentially hazardous radioactivity associated with isotopes inside the reactors. Consideration is also given to the future commercial feasibility of fission and fusion energies. It is concluded that both fission breeders and DT (deuterium/tritium) fusion have the potential, in terms of fuel supply, for providing extremely large amounts of electricity, with investment in R&D being very heavy and operation of the facilities demanding a high degree of alertness and thoroughness. Further, differences in the physical processes of fission and fusion are noted, particularly the capability of the fusion process to allow for a greater degree of flexibility in the technologies used to harness it.

A.A.

**A79-22768 Temperature dependence of photovoltaic solar energy conversion for GaAs homojunction solar cell.** P. C. Mathur, J. D. Arora (Delhi, University, Delhi, India), and N. D. Kataria (Delhi, University, Delhi; National Physical Laboratory of India, New Delhi, India). *Solid-State Electronics*, vol. 22, Jan. 1979, p. 111-112. 16 refs.

Calculations are reported for the efficiency of GaAs (p on n) homojunction solar cells in the temperature range 100-675 K for the entire solar spectrum. Calculations are based on available data for band structure, effective mass and mobility for n-type and p-type GaAs. It is found that the results are very sensitive to the band parameters and their temperature variation, due to the fact that the dark current density, to which efficiency is extremely sensitive, is quite small in GaAs.

B.J.

**A79-22847 # Thermal converters with transverse thermoelectromotive forces** (Termoelementi z poperechnimi termoelektrorushiiymi silami). L. I. Anatichuk and V. V. Razin'kov. *Akademii Nauk Ukrains'koi RSR, Visnik*, vol. 42, Nov. 1978, p. 50-59. 25 refs. In Ukrainian.

The design and principles of thermal converters of various type, based on the Seebeck effect, are examined, and their efficiency is compared. The theory of devices employing short-circuited thermoelements, of the type used to measure IR and laser radiations, is outlined.

V.P.

**A79-22855 Gold, silver, chromium, and copper cermet selective surfaces for evacuated solar collectors.** D. R. McKenzie (Sydney, University, Sydney, Australia). *Applied Physics Letters*, vol. 34, Jan. 1, 1979, p. 25-28. 9 refs. Research supported by the Science Foundation for Physics.

Cermetsolar selective surfaces of absorptance over 0.90 and emittance less than 0.05 have been prepared by vacuum coevaporation of alumina and spinel with gold, silver, chromium, and copper. Grading of composition was employed to enhance the absorptance. The effect of heat treatment in vacuum up to 500 C was studied and the chromium-alumina cermet shown to be the best candidate for vacuum-insulated collectors.

(Author)

**A79-22856 A two-junction cascade solar-cell structure.** S. M. Bedair, M. F. Lamorte (Research Triangle Institute, Research Triangle Park, N.C.), and J. R. Hauser (North Carolina State University, Raleigh, N.C.). *Applied Physics Letters*, vol. 34, Jan. 1, 1979, p. 38, 39. Research supported by the U.S. Department of Energy.

A two-junction cascade solar-cell structure has been demonstrated in the AlGaAs/GaAs materials system. The cell consists of two p-n junctions with different band gaps monolithically connected in series by means of a low-resistance p-n junction. An open-circuit voltage of 2.0 V has been observed for this cascade structure. This is the highest open-circuit voltage that has been reported for a single monolithic photovoltaic cell.

(Author)

**A79-22858 Microstructure dependence of the optical properties of solar-absorbing black chrome.** A. Ignatiev, P. O'Neill, C. Doland, and G. Zajac (Houston, University, Houston, Tex.). *Applied Physics Letters*, vol. 34, Jan. 1, 1979, p. 42-44. 15 refs. Research supported by the U.S. Department of Energy.

The surface microstructure and chemical constituency of solar-absorbing black chrome films have been studied by scanning electron microscopy (SEM), X-ray photoemission spectroscopy (XPS), and sputter depth-profiling techniques. The films have been determined to consist of a top layer of small (about 400 Å) Cr<sub>2</sub>O<sub>3</sub> particles with one or two sublayers of larger (about 1000 Å) closely packed chromium particles. In addition, it has been shown that the optical response of the particulate black chrome films is significantly determined by the microstructure of the films.

(Author)

**A79-22859 Explanation for low-efficiency Cu<sub>2</sub>O Schottky-barrier solar cells.** L. C. Olsen, R. C. Bohara (Joint Center for Graduate Study, Richland, Wash.), and M. W. Uri (Hanford Engineering Development Laboratory, Richland, Wash.). *Applied*

*Physics Letters*, vol. 34, Jan. 1, 1979, p. 47-49. NSF Grant No. AER-75-20501.

Surface analyses combined with barrier-height studies indicate that Cu<sub>2</sub>O Schottky barriers made with low-work-function metals (Yb, Mg, and Mn) are essentially Cu/Cu<sub>2</sub>O cells due to reduction of the Cu<sub>2</sub>O surface and subsequent interdiffusion phenomena. The copper-rich region essentially determines the barrier height. As a result, efficiencies of Cu<sub>2</sub>O Schottky-barrier solar cells are usually less than 1%. It is concluded that to achieve significant increases in Cu<sub>2</sub>O cell efficiencies, MIS or heterojunction device structures must be utilized. (Author)

A79-22862 Performance of a new high-intensity silicon solar cell. R. I. Frank and R. Kaplow (MIT, Cambridge, Mass.). *Applied Physics Letters*, vol. 34, Jan. 1, 1979, p. 65-67. 6 refs. Research supported by the National Patent Development Corp.

A new silicon solar cell, designed to have improved electrical, optical and thermal transfer characteristics at very high incident light intensities, has been fabricated and provides experimental verification of the basic design concepts. The AM1 efficiency for nonoptimized cells is 12.8% at 25°C. At 300 suns the efficiency increases to 19%. It is shown that efficiencies of over 25% are possible for this type of cell in a more-optimized form at intensities of about 500-1000 suns. (Author)

A79-22923 A theoretical study of wood gasification processes. W. J. Cousins (Department of Scientific and Industrial Research, Physics and Engineering Laboratory, Lower Hutt, New Zealand). *New Zealand Journal of Science*, vol. 21, June 1978, p. 175-183. 14 refs.

A thermodynamic theory that has been used successfully for many years to describe the gasification of coal is applied to the gasification of wood. Some modification of the theory is necessary to allow for the very high production of volatiles during the pyrolysis of wood. The use of the modified theory is illustrated by application to countercurrent and concurrent gasification of wood with air/steam and oxygen/steam blasts. (Author)

A79-22924 Wind power site evaluation. I - Wind energy potential. II - Data acquisition and processing. R. J. Clegg, M. D. Johns, and S. W. Pattemore (Auckland, University, Auckland, New Zealand). *New Zealand Journal of Science*, vol. 21, June 1978, p. 185-193; 195-204. 11 refs. Research supported by the University Grants Committee of New Zealand and University of Auckland.

A field station on the Whangaparaoa peninsula in New Zealand has provided data on wind speed and direction for a 12 month period. Data covering a six month period have been used to determine the wind power potential of the site. Analysis shows that the site has a mean wind energy flux of 464 W/sq m at a height of 10 m for the six month period; the estimate for the full year is 371 W/sq m. In addition, some aspects of the acquisition and processing of data relating to wind power site evaluation are discussed in detail. The effect of wind speed sampling intervals on the accuracy of wind power estimates was measured and some alternative methods of calculating wind power from the wind speed data were investigated. B.J.

A79-22925 Mercury in some New Zealand geothermal discharges. B. G. Weissberg and A. G. Rohde (Department of Scientific and Industrial Research, Chemistry Div., Lower Hutt, New Zealand). *New Zealand Journal of Science*, vol. 21, Sept. 1978, p. 365-369. 20 refs.

Mercury concentrations in the discharges from some New Zealand geothermal wells range from 1.0 to 61 micrograms Hg/kg of steam separated from water between 0.7 and 14 bar pressure (gauge), and from 0.02 to 0.12 micrograms Hg/kg of water separated from steam at atmospheric pressure. The concentration of mercury in the steam phase implies the presence of volatile mercury species such as elemental mercury, mercurous chloride, or organic mercury compounds in the geothermal fluid at depth. The total mercury added to

the Waikato River from the Wairakei geothermal scheme is about 55 kg of mercury per year or an average increment of 0.015 micrograms Hg/kg of river water. Although this is well below the limit recommended by the World Health Organization of 1.0 micrograms Hg/kg for mercury in potable water, the mercury may accumulate in sediments along with mercury from natural geothermal activity and other sources and contaminate fish after microbiological methylation. (Author)

A79-22977 # Single-particle behaviour in plasmas. B. McNamara (California, University, Livermore, Calif.). In: *Theoretical and computational plasma physics*; College, Trieste, Italy, March 22-April 9, 1977, Selected Lectures. Vienna, International Atomic Energy Agency, 1978, p. 5-25. 22 refs. Contract No. W-7405-eng-48.

The paper is a collection of the essential formulas and mathematical techniques for dealing with the motion of charged particles in electromagnetic fields as it applies to plasmas. The various useful forms of the method of averaging are displayed and applied to the calculation of constants of motion. The breakdown of these constants is discussed along with some of the implications for fusion systems. A theory of invariants is described that first shows how to average over a single frequency. Then it is modified to take into account the multifrequency case, where beats can produce a slow variation. The method is illustrated by a calculation of orbits for a charged particle in a uniform magnetic field interacting with an electrostatic plasma wave. P.T.H.

A79-22979 # Equilibrium relations in the presence of arbitrary plasma diffusion in axisymmetric configurations. D. Pfirsch (Max-Planck-Institut für Plasmaphysik, Garching, West Germany). In: *Theoretical and computational plasma physics*; College, Trieste, Italy, March 22-April 9, 1977, Selected Lectures. Vienna, International Atomic Energy Agency, 1978, p. 49-58. EURATOM-sponsored research.

A condition for general axisymmetric diffusive equilibria that relates the outward diffusion to the toroidal current density is derived. In an approximation version, it requires that some effective diffusion velocity must not exceed the poloidal magnetic diffusion velocity. Relevant consequences follow in the anomalous diffusion regime if diffusion is caused by an anomalous parallel electron viscosity instead of an anomalous perpendicular resistivity. In the former case, the effective diffusion velocity equals the real diffusion velocity, and an anomalous bootstrap current arises which leads to rather low upper limits for the poloidal beta. If the usual trapped ion or Bohm diffusion is assumed to be caused by enhanced viscosity, no stationary high-temperature equilibria would be possible in a system governed by the appropriate diffusion law. (Author)

A79-22980 # Collisional transport. D. Pfirsch (Max-Planck-Institut für Plasmaphysik, Garching, West Germany). In: *Theoretical and computational plasma physics*; College, Trieste, Italy, March 22-April 9, 1977, Selected Lectures. Vienna, International Atomic Energy Agency, 1978, p. 59-76. 11 refs.

Collisional particle and heat transport is treated in plane and toroidal geometry. In particular, temperature gradient effects on impurity diffusion - so-called temperature screening - are considered for the different collisional regimes. The existence of quasistationary self-consistent tokamak equilibria with finite resistivity and a possible limitation of the maximum beta caused by particle diffusion is discussed. (Author)

A79-22981 # Non-linear numerical algorithms for studying tearing modes. B. V. Waddell, M. N. Rosenbluth (Institute for Advanced Study, Princeton, N.J.), D. A. Monticello, R. B. White (Princeton University, Princeton, N.J.), and B. Carreras. In: *Theoretical and computational plasma physics*; College, Trieste, Italy, March 22-April 9, 1977, Selected Lectures. Vienna, International Atomic Energy Agency, 1978, p. 79-91. 9 refs. ERDA-sponsored research.

The numerical methods that have recently been developed to study the nonlinear evolution of tearing modes in tokamaks are summarized. The essential features of tearing modes can be described by the resistive MHD equations. The numerical algorithms described here are based on a reduced set of two-dimensional resistive MHD equations that are numerically tractable. Two distinct types of numerical methods are described in detail. In the first method, referred to as the MASSLESS algorithm, the inertia is neglected. On the other hand, in the second method, referred to as the MASS algorithm, the inertia is retained and consequently the scheme is capable of handling a larger variety of problems. Codes based on these two algorithms give similar results for the nonlinear evolution of the m = 2 tearing mode. (Author)

**A79-23027** Prepulse damage to targets and alignment verification. R. F. Benjamin and G. T. Schappert (California, University, Los Alamos, N. Mex.). *Journal of Applied Physics*, vol. 50, Jan. 1979, p. 7-10. 16 refs. Research sponsored by the U.S. Department of Energy.

The damage threshold of 10.6-micron light incident on glass microballoon laser fusion targets has been measured. The threshold is several dozen microjoules, depending on target size and laser pulse width, and the damage mechanism appears to be thermal heating and rupture. Perforating glass microballoons proves to be a useful alignment verification technique. (Author)

**A79-23034** Fuel content characterization and pressure retention measurements of DT-filled laser fusion microballoon targets. H. W. Deckman and G. M. Halpern (Exxon Research and Engineering Co., Linden, N.J.). *Journal of Applied Physics*, vol. 50, Jan. 1979, p. 132-139. 18 refs. Research supported by the University of Rochester.

A nondestructive assay of the fuel content of deuterium-tritium (DT)-filled microballoon laser fusion targets has been developed which is based on beta-particle counting rates. By using a model employing transmission measurements of kilovolt electrons through thin films, observed count rates are correlated with the amount of tritium in the glass walls and hollow interior of the microballoons. This assay technique is primarily applicable for balloons with glass wall thicknesses of less than 1.5 microns, where the number of escaping beta particles is large compared with the number of X-ray photons generated in the glass, and has been applied to measure the pressure-retention characteristics of individual targets. At room temperature the balloons exhibited widely diverse and rapid leakage rates which could not be correlated with a model based on molecular diffusion and the assumption that all balloons had a homogeneous composition. Cryogenic storage greatly reduced the leakage rates with pressure-retention half-lives ranging from 5 to approximately 12 years. (Author)

**A79-23039** The interfacial layer in MIS amorphous silicon solar cells. J. McGill, J. I. B. Wilson (Heriot-Watt University, Edinburgh, Scotland), and S. Kinmond (Dundee, University, Dundee, Scotland). *Journal of Applied Physics*, vol. 50, Jan. 1979, p. 548-550. 22 refs. Research supported by the Science Research Council and EEC.

When an insulating layer of TiO<sub>x</sub> is added beneath the Ni barrier contact of amorphous silicon Schottky diodes, increases are produced in both the open-circuit voltage and the short-circuit current. The former change is explained by an increased barrier height and diode factor, and the latter change is at least partially caused by an increase in the width of the space-charge region. (Author)

**A79-23125** Optimizing the conversion mode for solar energy. Iu. V. Mitrishkin. (*Avtomatika i Telemekhanika*, July 1978, p. 53-60.) *Automation and Remote Control*, vol. 39, no. 7; Dec. 10, 1978, p. 980-985. 8 refs. Translation.

Consideration is given to the automatic optimization of the operation of a solar energy converter (solar array, solar thermoelectric generator, etc.) in autonomous power-supply systems. The process of search for maximum power extracted from the converter

by means of a pulsed automatic optimizer is investigated. A dc-converter with parallel switch is used in the power circuit of the optimizer. B.J.

**A79-23137** Dynamic characteristics of a free-piston diesel engine combined with a MHD generator. B. M. Antonov, V. A. Bashkatov, Iu. M. Kirillov, I. N. Postnikova, S. S. Safonova, and E. E. Shpil'rain (Akademii Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). (*Teplofizika Vysokikh Temperatur*, vol. 16, May-June 1978, p. 611-619.) *High Temperature*, vol. 16, no. 3, Nov. 1978, p. 519-526. 5 refs. Translation.

The paper proposes a method for calculating the dynamic characteristics of a system consisting of a free-piston diesel engine and a liquid-metal MHD generator. Results of the computation of the dynamic, thermodynamic and cost-efficiency characteristics of the system are presented for the following initial conditions: independent excitation, a channel induction of 2 T, active electrical loading, a load coefficient of 0.95, a rectangular cross section of the MHD channel of 5 mm x 20 mm, and three different piston areas, 312, 467, and 623 sq mm. B.J.

**A79-23138** Construction of a mathematical model for MHD generator electrodes in the arc regime of operation. L. P. Poberezhskii (VNIIPtransprogress, USSR). (*Teplofizika Vysokikh Temperatur*, vol. 16, May-June 1978, p. 620-623.) *High Temperature*, vol. 16, no. 3, Nov. 1978, p. 527-530. 12 refs. Translation.

**A79-23280** Mining earth's heat - Hot dry rock geothermal energy. R. G. Cummings, G. E. Morris, J. W. Tester, and R. L. Bivins (California, University, Los Alamos, N. Mex.). *Technology Review*, vol. 81, Feb. 1979, p. 58-74, 78. 32 refs. Research supported by the U.S. Department of Energy.

It is estimated that energy amounting to 13,000,000 quads are contained in crustal rock to a depth of ten km in the U.S. The technology of HDR (Hot Dry Rock Geothermal Energy) is discussed, together with an assessment of size and quality of HDR resource, as well as of extraction approaches and problems of containment and recovery, emphasizing variations in reservoir design, operating parameter values, and financial and regulatory criteria. A model of a geothermal power plant is presented, noting that the selection of optimum plant design conditions becomes more complex as reservoir temperature declines. The base-case parameter values used in the optimization model to evaluate HDR energy for production of electricity are given, including life of the system (30 years), electric plant capacity (50 MW(e)), maximum well flow rate (75 kg/sec), geothermal gradient (40 C/km), busbar price of electricity (3 cents/kWh), and operation and maintenance costs (0.13 cents/kWh). It is concluded that if busbar costs are at the high end, a considerable incentive for HDR development would exist. A.A.

**A79-23295** Prediction of the behavior of a solar storage system by means of recurrent stochastic models (Prévision du comportement d'un système de stockage solaire à l'aide de modèles stochastiques récurrents). C. Bénard, Y. Body (CNRS, Paris, France), A. Wirgin (Paris VI, Université, Paris, France), and D. Gobin (Ecole Centrale des Arts et Manufactures, Châtenay-Malabry, Hauts-de-Seine, France). *La Météorologie*, Sept. 1978, p. 69-80. In French.

Procedures for constructing a recurrent stochastic model of solar energy storage are described, and two rough linear models, the W model and the B model, are presented. The models differ in the assumptions of loss and energy characteristics but produce similar results. Data on the a priori probability of good functioning of storage systems are presented for different assumed conditions. M.L.

**A79-23306** Wave-tank experiments on an immersed parallel-plate duct. G. F. Knott and J. O. Flower (Sussex, University, Brighton, England). *Journal of Fluid Mechanics*, vol. 90, Jan. 29, 1979, p. 327-336. Research supported by the Science Research Council.

The paper reports on some experiments performed on a fully submerged parallel-plate duct structure that oscillates in response to wave-induced pressures at its opening. Amplitude and phase of the direct and reflected wave trains on both sides of the duct were deduced, and measurements of the oscillating pressure in the enclosure were made. From these one calculated the pressure amplification ratio and the duct reflection coefficient. These preliminary experiments showed that the theory is fairly accurate and that appreciable amplification of duct pressures is possible, which is of importance for immersed pressure-driven wave-energy devices. P.T.H.

**A79-23307** A theory for wave-power absorption by two independently oscillating bodies. M. A. Srokosz and D. V. Evans (Bristol, University, Bristol, England). *Journal of Fluid Mechanics*, vol. 90, Jan. 29, 1979, p. 337-362. 22 refs. Research supported by the Science Research Council.

The paper gives a linear analysis of the problem of two arbitrary cylinders oscillating independently and capable of absorbing energy in a single mode from a given incident wave. It is shown how the general problem can be regarded as the superposition of the solution to the scattering problem in which the cylinders are held fixed in the incident wave, and the solution to the radiation problem in which each cylinder makes forced oscillations in turn, the other cylinder being held fixed, in the absence of the incident wave. It is shown that for a certain displacement of the cylinders, 100% wave-energy absorption efficiency is possible. An approximate method is presented for solving the radiation and scattering problems for two cylinders in terms of the solution for one cylinder. P.T.H.

**A79-23343** Photoelectrolysis of water with semiconductors. M. Tomkiewicz and H. Fay (Union Carbide Corp., Medical Products Div., Tarrytown, N.Y.). *Applied Physics*, vol. 18, Jan. 1979, p. 1-28. 149 refs.

The use of semiconductors as photoelectrodes in electrolytic cells is described and results reported in the literature for various semiconductors are reviewed. The most important properties of the semiconductor in this process are found to be the band-gap energy and the flat-band potential. For electrolysis to proceed, the potential corresponding to the band gap must appreciably exceed the standard potential for the electrolysis of water, 1.23 V. In addition, the flat-band potential must be more negative than the hydrogen potential or an external bias voltage is required. The use of solar energy in this process is considered and a general discussion is presented of the practical prospects of photoelectrolysis in comparison with solid state solar cells. B.J.

**A79-23458** East Mesa geothermal test site. W. A. Fernelius (U.S. Bureau of Reclamation, Div. of Planning, Boulder City, Nev.) and M. K. Fulcher (U.S. Bureau of Reclamation, Boulder City, Nev.). (*American Society of Civil Engineers, Annual Convention, Exposition and Continuing Program, San Francisco, Calif., Oct. 17-21, 1977.*) *American Society of Civil Engineers, Environmental Engineering Division, Journal*, vol. 105, Feb. 1979, p. 13-32. 5 refs.

The activities of the Bureau of Reclamation at East Mesa (California) Test Site and the results of its geothermal desalting program are described. Data on location, geothermal characteristics, and results of the chemical analysis of East Mesa geothermal wells are presented. Investigations including direct contact heat exchanger experiments, and energy conversion systems are mentioned, as are the well interference tests using highly sensitive electronic pressure gauges (over 0.01 psi). Injection operations are discussed, and it is found that wellhead silica concentrations appear to be related to flow rate. A seismic monitoring system, and a subsidence monitoring system, are outlined. The Multistage Flash (MSF), Vertical Tube Evaporator (VTE), and High Temperature Electrodialysis (HTED) desalting systems are discussed in detail. It is concluded that the systems have shown the capability to desalt geothermal fluid, and problems associated with each have been identified together with probable solutions. A.A.

**A79-23581 \*** Dynamic simulation studies of fuel conservation procedures used in terminal areas. P. J. O'Brien (FAA, National Aviation Facilities Experimental Center, Atlantic City, N.J.), L. Tobias, and E. A. Palmer (NASA, Ames Research Center, Moffett Field, Calif.). In: *Air Traffic Control Association, Annual Fall Conference, 23rd, Fort Worth, Tex., October 2-5, 1978, Proceedings*. Washington, D.C., Air Traffic Control Association, Inc., 1978, p. 9-15.

A simulation program was devised to study the effects of fuel conservation procedures on ATC and terminal area operations. The FAA National Aviation Facilities Experimental Center and the Ames Research Center have interconnected ATC and piloted simulation facilities at both centers. A unique national simulation facility for the study of pilot/controller/system interactions was established. The present paper describes the simulation facilities and outlines aircraft operational procedures evaluated in the experiments. Two experiments studied are discussed: the first involves two types of landing approaches, while the second involves both landing approaches and profile descents. B.J.

**A79-23599** MHD instabilities. G. Bateman. Cambridge, Mass., MIT Press, 1978. 270 p. 285 refs. \$22.50.

The MHD equations are considered along with the Rayleigh-Taylor instability, linearized equations and the energy principle, toroidal instabilities, high beta tokamaks, nonlinear instability theory, resistive instabilities, and a comparison between theory and experiment. The characteristics of the MHD equilibrium are examined, taking into account force balance equations, surface quantities, the q-value, the Grad-Shafranov equation, an example of bifurcation related to a cylinder with elongated cross section, a plasma squeezed between conducting walls, and the tokamak equilibrium. Circular cylinder instabilities are also investigated, giving attention to aspects of equilibrium, the physical picture of current driven instabilities, the 1-D eigenvalue equation, the 1-D energy principle, fixed-boundary instabilities, and free-boundary instabilities. G.R.

**A79-23600 #** A planning and information system for strategic energy policy assessment. S. Hannus. Research supported by the Finnish Cultural Foundation and Technological Foundation. Helsinki, Kyriiri Oy, 1978. 161 p. 22 refs.

A quantitative planning and information system for strategic energy policy assessment is constructed. The purpose is not to model the energy system but to arrange knowledge of the system into a useful form. The energy system is analyzed, and the information system, which includes an information processing component with four separate data processing systems and the planning data base, is described. Validation of the system is considered, and two scenarios for the future, one a crisis scenario, are examined. The design, construction, application, and evaluation of the information system are discussed. M.L.

**A79-23603** International Conference on Thermoelectric Energy Conversion, 2nd, University of Texas, Arlington, Tex., March 22-24, 1978, Proceedings and Supplement. Conference sponsored by the Institute of Electrical and Electronics Engineers and University of Texas. Edited by K. R. Rao. New York, Institute of Electrical and Electronics Engineers, Inc., 1978. Proceedings, 142 p.; Supplement, 17 p. \$30.

Papers are presented on thermoelectric (TE) materials and properties, novel applications and analysis of TE devices, TE systems design, and TE generators. Particular consideration is given to such topics as the comprehensive thermoelectric behavior of selected n-type and p-type silicon-germanium alloy, design concepts of solar thermoelectric generators in space applications, estimation of heat loads in multistage thermoelectric coolers, reversible thermoelectric power conversion of energy fluctuations, and regenerative burner systems for thermoelectric power sources. B.J.

**A79-23604 \*** Comprehensive thermoelectric properties of n- and p-type 78a/o Si - 22a/o Ge alloy. V. Raag (Syncal Corp.,

## A79-23609

Sunnyvale, Calif.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 5-10. Contract No. NAS7-100.

The time and temperature dependence of the thermoelectric properties on n- and p-type 78 a/o Si - 22 a/o Ge alloy are presented in detail for the range of temperatures of zero to 1000 C and operating times up to twelve years. The mechanisms responsible for the time dependence of the properties are discussed and mathematical models used in the derivation of the property values from experimental data are presented. The thermoelectric properties for each polarity type of the alloy are presented as a function of temperature for various operating times. (Author)

**A79-23609** On an irreversible thermodynamic analysis of thermoelectric devices. O. A. Arnas (Louisiana State University, Baton Rouge, La.) and D. L. Miller. In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 36-40. Research supported by the Olin Corp.; NSF Grant No. EPP-75-04148.

Irreversible thermodynamics attempts to describe dynamic state changes in thermoelectric materials through the derivation of an entropy balance equation which equates physical processes to the respective changes in entropy. A unified energy theory of thermoelectric behavior is derived on the basis of conservation equations, phenomenological laws, the Curie principle, and the Onsager relations. The approach is used to analyze a thermoelectric generator, and methods of calculating the power output of this device are suggested. B.J.

**A79-23612 \*** Design concepts of solar thermoelectric generators in space applications. V. Raag, L. Hankins (Syncal Corp., Sunnyvale, Calif.), and M. Swerdlung (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 60-65. Contract No. NAS7-100.

Several thermoelectric technologies have been examined as to their suitability for use in a solar thermoelectric generator (STG) as a nonpropulsive power source for space applications. The results show that of all the presently available thermoelectric technologies, i.e., lead telluride, bismuth telluride, selenide, and silicon-germanium alloys, the latter type provides the optimum STG. Detailed results are presented on the performance and configurational characteristics of various silicon-germanium alloy STGs, including the performance of such STGs as a function of time in a Mercury orbit and the orbit of Mercury around the sun. It is shown that an STG design based on the use of silicon germanium alloy thermoelectric material, using multiple high voltage thermopiles with individual solar concentrators, presents the optimum combination of technology and configuration for minimizing power source mass. Additional concepts studied and discussed are the flat plate-individual thermopile type and single concentrator compact thermopile type. The STG possesses an attractive potential for this application and represents a useful addition to the family of power sources for consideration in various space applications. (Author)

**A79-23613** Optimization method of isotopic thermoelectric microgenerator geometry. T. Wartanowicz and J. Zembrzuski (Warszawa, Politechnika, Warsaw, Poland). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 66-71.

The subject of the analysis is a microgenerator, i.e. a generator having a power output under 500 mW. The generator geometry optimization is based on the isotopic source thermal power minimization for its given rated electric parameters, i.e. power and voltage.

The optimization procedure makes it possible to present graphically the results of calculations. (Author)

**A79-23614** Estimating heat loads on multistage thermoelectric heat pumps. R. Marlow and P. B. Click, Jr. (Marlow Industries, Inc., Garland, Tex.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 72-81.

To optimize the design of a thermoelectric heat pump for minimum input power, it is necessary to make a good estimate of the heat load. Multistage thermoelectric heat pumps are required to cool temperature sensitive components to 233 K or colder. In these cases the relationship of coefficient of performance, vs cold side temperature indicates that any small error in the heat load calculation is reflected as a large error in input power. The relationship of heat load and input power relative to cold side temperature is discussed in this paper. Graphical presentations are used to estimate the heat loads for these examples and to show the effect on input power. Typical examples are as follows: (1) cooling of a multielement infrared detector array to 193 K, (2) cooling of a single element silicon laser sensor to a temperature of 163 K, (3) cooling a self scanned array chip to 233 K in xenon. Each example has specific problems in evaluating heat load and input power requirements.

(Author)

**A79-23615** Method of producing a p-type or n-type alloy for direct thermoelectric energy conversion. M. C. Nicolaou (Santander, Universidad Industrial, Bucaramanga, Colombia). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 82-85. 24 refs.

**A79-23616** Some effects of leg surface heat losses on the performance of a p-n type thermoelectric generator. E. F. Thacher and M. H. Cobble (New Mexico State University, Las Cruces, N. Mex.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 86-89.

A preliminary analysis of the effects of leg surface heat loss on the transient and steady-state performance of a thermoelectric generator was performed for the case of a constant and uniform overall heat transfer coefficient applied to the leg surfaces, temperature dependent material properties (except for density and specific heat), and constant hot and cold shoe temperatures. The results are that as the heat transfer coefficient is increased the leg temperature distributions become markedly non-linear, the internal resistance decreases, the output power and current increases slightly, the input power increases, the time to equilibrium decreases, and the efficiency decreases. (Author)

**A79-23618** Efficiency of a series of thermoelectric generators in a solar wedge concentrator. M. H. Cobble (New Mexico State University, Las Cruces, N. Mex.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 100-103.

A system for generating electrical power from solar energy utilizing a non-tracking wedge to concentrate sunlight onto a series of M thermoelectric generators, cooled by a heat exchanger, is analyzed. Expressions are developed for the temperature distribution in the p and n legs, and for the temperatures of the hot junctions and, cold junctions and the temperature distribution in the fluid, the electrical work efficiency and the efficiency of heating the cooling fluid. The wedge concentration is given as a function of the wedge 1/2 angle, and the included angle of incidence. Utilizing the theory in an example, the electrical work efficiency and fluid heating

efficiency are shown plotted against concentration and mass flow rate in separate figures. Additionally the temperature distribution in the hot plate junctions, cold plate junctions and in the cooling fluid are plotted vs. distance for a typical problem.

(Author)

**A79-23619** Reversible thermoelectric power conversion of energy fluctuations. J. C. Yater (Energy Unlimited, Inc., Lincoln, Mass.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 107-114. 17 refs. Research supported by the U.S. Department of Energy.

The results of an analysis of an independent particle model for both classical and quantum effects show that a reversible thermoelectric converter with power conversion of energy fluctuations has the potential of achieving the maximum efficiency of the Carnot cycle. The device utilizes the electric fluctuation energy of small circuits at a different temperature so as to produce useful energy and can efficiently pump heat from lower to higher temperatures. Several applications of this device are described including earth solar power, steam power plants, topping and tailing, space solar power stations, and heat pumps or refrigerators.

B.J.

**A79-23621** Regenerative burner system for thermoelectric power sources. G. Guazzoni, J. Angello, and A. Herchakowski (U.S. Army, Electronics Technology and Devices Laboratory, Fort Monmouth, N.J.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings.

New York, Institute of Electrical and

Electronics Engineers, Inc., 1978, p. 121-125.

A thermoelectric power source is being developed to provide a multifuel, silent, maintenance free tactical power generator for forward area applications. Formal testing of prototype models of the 500-Watt Thermoelectric Power Source has demonstrated its ability as an improved source of power for military equipment in a wide range of environmental conditions. This unit will replace the troublesome gasoline engine-driven generator sets which are noisy, unreliable, and require frequent maintenance. Maximum efficiency during operation of the thermoelectric power source will assure an effective utilization of fossil fuel in support of Army mission requirements and energy conservation. Test results not only show significant reduction in fuel consumption, but also indicate that preheating of the primary air for combustion provides a practical solution for the elimination of carbon accumulation in the burner system. (Author)

**A79-23622 #** Determining the reliability of radioisotope thermoelectric generators /RTGs/ designed for terrestrial and undersea applications. F. E. Rosell, Jr. (Defense Systems Management College, Fort Belvoir, Va.) and J. F. Vogt (U.S. Navy, Naval Nuclear Power Unit, Port Hueneme, Calif.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Supplement.

New York, Institute of

Electrical and Electronics Engineers, Inc., 1978, 7 p.

Field experience with RTG power sources in harsh environments is reviewed with attention given to the use of RTGs for oceanographic sensors, in meteorological stations, and in undersea structures. Particular attention is given to the reliability determination of RTGs on the basis of accelerated testing and some recommendations for improving the reliability of RTGs, particularly of the plutonium-238-fueled half-watt type, are presented.

B.J.

**A79-23623 #** Recent terrestrial and undersea applications of radioisotope thermoelectric generators /RTGs/. F. E. Rosell, Jr. (Defense Systems Management College, Fort Belvoir, Va.) and J. F. Vogt (U.S. Navy, Naval Nuclear Power Unit, Port Hueneme, Calif.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Supplement.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, 5 p.

This paper discusses recent projects utilizing strontium-90 RTGs under diverse conditions at various global locations, and covers

progress on the Navy's plutonium-fueled superbattery. The purpose of this paper is to demonstrate that RTGs provide practical, reliable sources of power for many types of applications for electronic systems in inaccessible locations, and to discuss some of the problems encountered in these applications.

(Author)

**A79-23624 #** Stability of work and sensitivity of semiconductor thermoelectric systems under automatic control. A. G. Makhlil (Unimation, Inc., Danbury, Conn.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Supplement.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978. 4 p.

Some theoretical considerations on the selection of a controller for temperature control by means of a thermoelectric heat pump are presented. The selection is made on the basis of the transient response and dynamic characteristics of the thermoelectric battery, and a transfer function for the battery is obtained and analyzed. An analysis of the self-oscillating operating mode shows that the two-position controller provides the necessary quality of control for a thermoelectric air-to-air type heat pump.

B.J.

**A79-23640** Emissions from pressurized fluidized-bed combustion processes. K. S. Murthy, J. E. Howes, H. Nack (Battelle Columbus Laboratories, Columbus, Ohio), and R. C. Hoke (Exxon Research and Engineering Co., Linden, N.J.). *Environmental Science and Technology*, vol. 13, Feb. 1979, p. 197-204.

The results of a comprehensive analysis of emissions from a pressurized fluidized-bed combustion (FBC) unit are presented. The analysis comprised approximately 740 measurements on about 90 samples from nine streams, including coal feed, dolomite feed, second stage cyclone discard, bed reject material, undiluted stack gas, diluted stack gas, cyclone discharge leachates, bed reject material leachates, and dilution and combustion air. A brief discussion of the sampling methods and analytical techniques is given. Major conclusions are (1) comprehensive analysis of emissions from emerging energy technologies yields useful results for environmental assessment of the processes; (2) pressurized coal-burning FBC units can meet existing new source performance standards for SO<sub>2</sub> and NO<sub>x</sub> emissions from coal-fired steam generators; and (3) minimum acute toxicity effluent standards for SO<sub>2</sub>, NO<sub>x</sub>, and CO need reevaluation.

P.T.H.

**A79-23710** High-efficiency AlGaAs/GaAs concentrator solar cells. R. Sahai, D. D. Edwall, and J. S. Harris, Jr. (Rockwell International Science Center, Thousand Oaks, Calif.). *Applied Physics Letters*, vol. 34, Jan. 15, 1979, p. 147-149. 9 refs.

Efficiencies of 25% have been obtained with 1-cm-diam AlGaAs/GaAs heteroface concentrator solar cells utilizing an ultrathin AlGaAs window layer design. A low specific resistance (greater than 0.005 ohm-sq cm) Ohmic contact is achieved by direct contact to the p-GaAs active layer. Liquid phase epitaxy has been developed to grow (greater than 500 Å) thick window layers on large-area (3.3 x 3.3 cm) GaAs substrates. Four 1-cm-diam cells are produced from each wafer and demonstrate the potential for larger-scale production.

(Author)

**A79-23718** Energy storage efficiency for the ammonia/hydrogen-nitrogen thermochemical energy transfer system. O. M. Williams and P. O. Carden (Australian National University, Canberra, Australia). *International Journal of Energy Research*, vol. 3, Jan.-Mar. 1979, p. 29-40. 10 refs.

The method used to calculate the energy storage efficiency for the solar thermochemical energy transfer system based on ammonia/hydrogen-nitrogen is described. A criterion that the correct value of separation work for a two-phase mixture must be generated internally by degradation of mixing heat is adopted, and thermodynamic data are generated from available phase equilibrium measurements with application of the criterion. Energy storage efficiencies are shown to increase towards unity as the endothermic reaction approaches completion; efficiencies greater than 0.90 are obtained for reaction extents exceeding 0.60. The analysis is

## A79-23719

supported by a comparison of analytic results with experimental results. M.L.

**A79-23719** Synthetic oil from coal - The economic impact of five alternatives for making hydrogen from coal and steam. H. F. Moore, E. T. Kim, and R. I. Kermode (Kentucky, University, Lexington, Ky.). *International Journal of Energy Research*, vol. 3, Jan-Mar. 1979, p. 41-57. 16 refs. Research supported by the Institute for Mining and Minerals Research and Ashland Oil Co.; NSF Grant No. AER-73-0359-A02.

The economics of liquefying coal by catalytic hydrogenation have been examined for five cases. The first three cases determined the effect upon the cost of syncrude of producing a syngas from coal and steam suitable for making hydrogen at pressures of 44.7 psia, 500 psia and 1000 psia. In the fourth case a carbonization step was included which produced a char suitable for gasification and a liquid product which was upgraded to a syncrude consuming 2000 SCF of hydrogen per bbl. In the last case all of the coal was liquefied and a vacuum bottoms material gasified to produce hydrogen. For all five cases the cost of syncrude was calculated using discounted cash flow (DCF) rates of 10, 15, and 20 per cent coal costs of \$10, \$20, \$30 and \$40 per ton, and several methods of by-product fuel valuation. Sensitivity analysis was performed on the operating costs, plant life, operating attainment schedule, and method of financing. Finally, a cost comparison between syncrude and natural World oil in the years 1985 and 1990, assuming yearly inflation rates of 5 and 10 per cent, has been made. (Author)

**A79-23721** Synthetic chloroplasts. M. Calvin (California, University, Berkeley, Calif.). (*International Symposium on Chloroplast Development, Spetsai, Greece, July 15-19, 1978.*) *International Journal of Energy Research*, vol. 3, Jan-Mar. 1979, p. 73-87. 25 refs. Research sponsored by the U.S. Department of Energy.

The development of synthetic chloroplasts is discussed, and natural and synthetic chloroplast characteristics are examined. While the proposed synthetic chloroplasts will contain no protein, the synthetic chloroplast system will mimic the way in which the green plant takes (four) quanta to generate oxygen on one side and reducing power on the other side of the membrane. The photo-induced electron transfer from a porphyrin in a micelle to a quinone in aqueous solution has been demonstrated directly, and future steps in the development of the synthetic chloroplast are indicated. M.L.

**A79-23751** Structuring a small national or state solar energy program. W. H. Jones (West Florida, University, Pensacola, Fla.) and M. M. Yarosh (Florida Solar Energy Center, Cape Canaveral, Fla.). (*International Solar Energy Society, Annual Meeting, New Delhi, India, Jan. 15-21, 1978.*) *Solar Energy*, vol. 22, no. 1, 1979, p. 1-7. 14 refs.

The methodology developed for structuring a state solar energy plan consisted in conducting an analysis of energy end-use patterns, reviewing these patterns in terms of available solar technologies, selecting the most promising technologies, and modifying the results by incorporation of a number of relevant social, economic, and political communities of interest. The paper describes the application of this methodology to the case of Florida's solar energy program. End-use analysis showed that Florida's energy problems would be best met by development of relatively low temperature solar energy methods for heating and air conditioning, while solar electric technology is not of interest to Florida. A systems analysis for the Florida program is proposed, that would consist of periodic reviews and updating of a program plan in solar energy, analysis of the impact of solar implementation on the existing energy distribution network and energy use patterns, analysis of the current status of solar cooling systems, and analysis of possible agricultural and industrial uses for solar energy. Considerations of testing, commercialization, and information dissemination are discussed. P.T.H.

**A79-23752** Buoyancy effects in a solar regenerator. P. Gandhidasan, V. Sriramulu, and M. C. Gupta (Indian Institute of Technology, Madras, India). *Solar Energy*, vol. 22, no. 1, 1979, p. 9-14. 12 refs.

In laminar forced solar regenerator the temperature of absorbent solution is different from that of the air passing over it and on account of low velocities used buoyancy forces are always present. This paper deals with the theoretical investigations of first order deviation of heat and mass transfer rates due to the buoyancy effect. The governing equations have been solved by using the Runge-Kutta method. Analysis shows that the ratio of solution film velocity to air stream velocity is an important parameter that governs the performance of solar regenerators. It has been found that the effect of buoyancy is more on local heat transfer than on local mass transfer. (Author)

**A79-23753** Isotropic distribution approximation in solar energy estimations. J. V. Dave (IBM Scientific Center, Palo Alto, Calif.). *Solar Energy*, vol. 22, no. 1, 1979, p. 15-19. 5 refs.

Results of numerical calculations of the direct solar energy and the diffuse sky radiation energy passing through a tilted surface are presented for five different models of the cloud-free midlatitude summer atmosphere. The results are for models resting on a perfectly absorbing ground, and for tilted surfaces with their outward normal in the sun's meridian plane. It is shown that isotropic distribution approximations for the sky radiation can lead to errors of as much as 300-400% in the estimations of the diffuse sky energy passing through a tilted surface. P.T.H.

**A79-23754** A comparison of compound parabolic and simple parabolic concentrating solar collectors. D. P. Grimmer (California, University, Los Alamos, N. Mex.). *Solar Energy*, vol. 22, no. 1, 1979, p. 21-25. 6 refs. Research sponsored by the U.S. Department of Energy.

The compound parabolic and simple parabolic solar collectors are analyzed and compared for their ability to accept nondirect radiation and for their respective reflector arc lengths. The simple parabolic concentrator (SPC) can make use of some nondirect solar radiation if the absorber tube is intentionally enlarged so as to intercept defocussed radiation. A principal advantage of collecting non-direct radiation with a SPC rather than with a compound parabolic concentrator (CPC) is the reduced materials use in the construction of the reflector, but a principal disadvantage is the reduction of acceptance angle to about 1/3 that of the CPC. However, a SPC with concentration ratio less than 10 can still collect most of the circumsolar nondirect radiation. (Author)

**A79-23755** Experiments with a flat plate solar water heating system in thermosyphonic flow. A. Shitzer, D. Kalmanoviz, Y. Zvirin, and G. Grossman (Technion - Israel Institute of Technology, Haifa, Israel). *Solar Energy*, vol. 22, no. 1, 1979, p. 27-35. 18 refs. Research supported by the Messing Foundation.

A typical Israeli water heating system in thermosyphonic flow was tested. The system consisted of two flat plate collectors painted matt black connected in parallel and a 140-liter storage tank. Total surface area of the collectors, employing the parallel flow pattern, was about 3 sq cm and they were tilted about 35 deg relative to the horizon. All collector pipes and connecting tubes were made of galvanized steel. The underside collector plate, collector tubes and storage tank were equipped with thermo-couples. A specially designed flow meter was used to measure water flow rate. Results show relatively linear temperature distributions both along the collectors and in the storage tank when no water consumption was allowed. Water flow rate was found to essentially follow solar radiation and reached a maximum of about 950 cu cm/min. This value was found to be about 33 per cent smaller than the one predicted by an analytical model developed by the authors. It was also observed that shutting the system off during the afternoon hours, when losses to the environment are enhanced, might increase system efficiency. (Author)

**A79-23757** Study of solid-gas-suspensions used for direct absorption of concentrated solar radiation. M. Abdelrahman (National Council for Research, Institute of Solar Energy, Khartoum, Sudan), P. Fumeaux, and P. Suter (Lausanne, Ecole Polytechnique

Fédérale, Lausanne, Switzerland). *Solar Energy*, vol. 22, no. 1, 1979, p. 45-48. 9 refs.

Suspensions of solid particles of the appropriate diameter in gases have interesting selective absorption properties, as they absorb solar radiation, whereas the emissivity in the IR range is low. For the numerical evaluation of the important factors governing this absorption, the absorption cross section obtained by Mie Theory was substituted in the Beer-Lambert relation of different conditions. For a given concentration and optical depth, the absorption was found to be dependent on the imaginary part of the complex index of refraction of the material used. It is also dependent on the size of the particle (represented by the diameter in case of spherical particles). For solar spectrum and spherical particles, the recommended values are 0.6 for the imaginary part of the refractive index and 0.5 micron for the diameter. These values may be satisfied by spherical particles of graphite. (Author)

**A79-23758** Solar thermal electric power systems - Comparison of line-focus collectors. W. W. Shaner and W. S. Duff (Colorado State University, Fort Collins, Colo.). *Solar Energy*, vol. 22, no. 1, 1979, p. 49-61. 15 refs.

Three types of line-focusing collectors: parabolic trough, fixed slats with movable absorber and movable slats with fixed absorber, are evaluated to find those systems that are capable of producing the lowest costs of electrical energy. Minimum costs per kW-hr are found using sequential optimization techniques that consider variations in rim angle, reflectance, aperture width, length, orientation, tracking, contour error, slat width, slat curvature, tangent slat angle, slope, installation methods, materials, fabrication methods, absorptance, emittance, cover transmittance, field shape, layout, pipe sizes, insulation thickness and turbine-generator-cooling tower efficiencies and designs. This approach provides a uniform treatment of both cost and performance for a solar thermal electric power system. This uniform treatment of solar thermal electric power systems for all collector types insures valid comparisons are made. (Author)

**A79-23760** Prediction of the performance of solar heating systems utilizing annual storage. P. J. Lunde (Center for the Environment and Man, Inc., Hartford, Conn.). *Solar Energy*, vol. 22, no. 1, 1979, p. 69-75. 5 refs.

Integrated performance equations are derived for a solar heating system in which a flat plate collector heats a well-mixed storage tank and is operated piecewise continuously. The analysis takes into account situations where the storage temperature is steadily rising from a base temperature to a final temperature or steadily dropping from a starting temperature to a final temperature. Daily heat collection with or without load can be estimated with better than engineering accuracy. For systems using annual storage, monthly system performance is predicted accurately by an integrated storage equation in those months when solar supply exceeds demand, and by an integrated collector equation in the opposite case. P.T.H.

**A79-23761** Optimum collector slope for residential heating in adverse climates. M. Iqbal (British Columbia, University, Vancouver, Canada). *Solar Energy*, vol. 22, no. 1, 1979, p. 77-79. 7 refs. Research supported by the National Research Council of Canada.

Optimum collector slope for a liquid base active solar heating system employing flat-plate collectors was investigated. The optimum collector slope was studied as a function of (1) collector area, (2) yearly total heating load and (3) the ratio of space heating load to service hot water load. Collectors facing equator only were considered. Such a system was studied in four different Canadian locations, having widely different climates. Under the above conditions, optimum collector slope varied with the amount of collector area employed. The optimum collector slope was invariant with the yearly total load itself, or the space heating to hot water load ratio. Contrary to the widely held belief, for the four locations investigated, the optimum collector slope varied from latitude - 10 deg to latitude + 15 deg, depending on the fraction of load supplied by the solar system. When this fraction is in 10-20 per cent range, optimum collector slope is latitude - 10 deg and increases almost linearly to

latitude + 15 deg at 80%. Consequently, when the fraction of load by the solar system is low, a flat roof may be profitably employed. On the other hand, when the fraction by the solar system is high, a south facing (for northern hemisphere) vertical wall may be profitably employed. (Author)

**A79-23763** Solar radiation charts. R. L. Nicholls and T. N. Child (Delaware, University, Newark, Del.). *Solar Energy*, vol. 22, no. 1, 1979, p. 91-97. 10 refs.

An equation proposed by Klein (1977) for the ratio of average daily beam radiation on a tilted plane to that on a horizontal plane at the earth's surface was solved and the results are presented in the form of solar radiation influence charts for latitudes 30, 40, and 50 N for all months of the year. Also, equations proposed by Liu and Jordan (1962) for the ratio of average daily radiation on a tilted plane to that on a horizontal plane at the earth's surface are considered, and charts for easy calculation of coefficients are presented. P.T.H.

**A79-23764** Flux-redistribution in the focal region of a planar Fresnel ring mirror. M. S. A. Sastroamidjojo (Gadjah Mada University, Jogjakarta, Indonesia) and W. Lubis (North Sumatra, University, Medan, Indonesia). *Solar Energy*, vol. 22, no. 1, 1979, p. 99-102.

An arrangement is described with which it is possible to obtain three-dimensional visualization of the effect of flux redistribution at the focal area of concentrating devices with large aberrations. A large parabolic mirror furnishing a parallel beam operates in conjunction with a cotton thread grid providing a matrix of 25 x 25 data points to construct a three-dimensional model of the focal region of a planar Fresnel ring mirror. The grid makes it possible to plot isoenergetic lines on a plane a given distance from the mirror. Several such plots for different distances give the three-dimensional picture of the focus. P.T.H.

**A79-23776** Modeling and simulation. Volume 9 - Proceedings of the Ninth Annual Pittsburgh Conference, University of Pittsburgh, Pittsburgh, Pa., April 27, 28, 1978. Part 1 - Energy and power system modeling - Ecological and biomedical modeling. Part 2

Socioeconomic modeling. Part 3 - Control and identification. Part 4 - Methodology and applications. Conference sponsored by the University of Pittsburgh. Edited by W. G. Vogt and M. H. Mickle. Pittsburgh, Pa., Instrument Society of America, 1978. Pt. 1, 489 p.; pt. 2, 436 p.; pt. 3, 408 p.; pt. 4, 365 p. Price of four parts, \$75; \$20.

The modeling studies presented in this volume include energy and power system modeling, ecological and biomedical modeling, socioeconomic modeling, control systems and system identification, and algorithms and general simulation techniques. Individual topics explored include multiobjective programming and regional energy, a hybrid dynamic programming/branch-and-bound approach to general planning, models for environmental transport of radionuclides in forests, Kalman filter and finite-memory filter in multilateration, a sample-data attitude control system for the Magsat spacecraft, modeling and performance evaluation of self-diagnosing systems, nonlinear two-dimensional filtering for noise discrimination, and an explicit method for system simulation with stochastic inputs. P.T.H.

**A79-23777** A fundamental model for the evolution of a two-phase geothermal reservoir with application to environmental impact analysis. R. W. Atherton, R. B. Schainker, and A. E. DeGance (Systems Control, Inc., Palo Alto, Calif.). In: Modeling and simulation. Volume 9 - Proceedings of the Ninth Annual Pittsburgh Conference, Pittsburgh, Pa., April 27, 28, 1978. Part 1.

Pittsburgh, Pa., Instrument Society of America, 1978, p. 67-73. 16 refs.

The time evolution of reservoir pore pressure in a geothermal resource is important both for the proper development of the energy resource as well as the mitigation and control of land subsidence potential. We have developed a fundamental model for the evolution

## A79-23780

of a two-phase (steam, hot-water) geothermal reservoir. The principal physical processes have been identified through the use of reservoir engineering principles. When coupled with a simplified model for reservoir compaction, the model is capable of estimating the subsidence potential of a given exploitation scheme and evaluating strategies for its mitigation. The models were successfully applied to data for the Wairakei reservoir in New Zealand. Based upon the insight derived from the model's development, field operating policies to mitigate subsidence are proposed. (Author)

**A79-23780** An economic analysis of synthetic fuels production from eastern oil shale via hydroretort processing. C. Lin (Texas Tech University, Lubbock, Tex.) and D. G. Nichols (Research Triangle Institute, Research Triangle Park, N.C.). In: Modeling and simulation. Volume 9 - Proceedings of the Ninth Annual Pittsburgh Conference, Pittsburgh, Pa., April 27, 28, 1978. Part 1. Pittsburgh, Pa., Instrument Society of America, 1978, p. 283-288. 15 refs.

A process analysis and cost engineering evaluation has been performed on the hydroretorting processes for the production of clean liquid and/or gaseous fuels from a typical oil shale of the eastern United States. The results include required capital investments, operating costs and the unit product price for the two conversion process flowsheets studied. (Author)

**A79-23781** System performance predictions for solar cooling using regional stochastic weather models. E. O. Bazques and I. N. Deif (Maryland, University, College Park, Md.). In: Modeling and simulation. Volume 9 - Proceedings of the Ninth Annual Pittsburgh Conference, Pittsburgh, Pa., April 27, 28, 1978. Part 1.

Pittsburgh, Pa., Instrument Society of America, 1978, p. 289-294. 6 refs. Contract No. EY-76-S-05-4976-A003.

A probabilistic approach is used to compact real climatological data collected for several regions. This stochastic weather information, which retains weather history, is then used to predict system performance of an air-cooled solar powered air-conditioning system for these diverse climatic regions of the United States. The system simulation incorporates a flat-plate solar collector, absorption cooling components, hot storage, load calculations and automatic controls. System coefficient of performance and total insolation using the stochastic approach are seen to be in good agreement with simulation runs using real weather data when compared over the total cooling season. It is concluded that even for diverse climatic regions the present scheme of reducing a large body of local data while retaining its probabilistic structure gives the designer a compact and inexpensive tool for sizing solar systems. (Author)

**A79-23808** Digital or analog modelling in the design of hydrostatic vehicular systems. J. V. Svoboda (Concordia University, Montreal, Canada). In: Modeling and simulation. Volume 9 - Proceedings of the Ninth Annual Pittsburgh Conference, Pittsburgh, Pa., April 27, 28, 1978. Part 4. Pittsburgh, Pa., Instrument Society of America, 1978, p. 1537-1541. 6 refs. Research supported by the National Engineering Laboratory of England; National Research Council Grant No. A-4213.

This paper discusses the use of both the digital and the analog computer modelling in the design and performance evaluation of complex hydraulic systems. The design examples of two hydrostatic vehicular drives are presented. One drive is suited for small urban cars, the other was designed for urban transport buses. Both drive systems utilize hydraulic accumulator as an energy storage assisting in vehicle acceleration and permitting regenerative braking. It is shown that the 'on-line' features of analog computing systems are indispensable in the design conception stage whereas the digital systems are more appropriate for system performance evaluation due to their practically unlimited computing capacity. (Author)

**A79-23809** Optimization of a novel hydrostatic drive performance using hybrid computing technique. J. V. Svoboda, S. Sankar (Concordia University, Montreal, Canada), and W. Blach (Rolls-Royce /Canada/, Ltd., Montreal, Canada). In: Modeling and

simulation. Volume 9 - Proceedings of the Ninth Annual Pittsburgh Conference, Pittsburgh, Pa., April 27, 28, 1978. Part 4.

Pittsburgh, Pa., Instrument Society of America, 1978, p. 1543-1547. 8 refs. National Research Council Grants No. 042-271; No. 040-293.

The paper describes the performance optimization of a novel hydrostatic vehicular drive using the hybrid computing technique system consisting of a small IC-engine, a hydrostatic transmission and a hydraulic accumulator energy storage which facilitates regenerative braking and was conceived with the aid of the analog computer. Thus obtained preliminary design was repeatedly 'driven' through a short driving cycle under the control of the digital computer. The direct search optimization routine stored in the digital system monitored and evaluated the drive performance, and readjusted two drive controller parameters. The objective of the optimization was to minimize the fuel consumption without any loss of drive dynamics. The comparison of the drive performance before and after optimization is presented and discussed. (Author)

**A79-23827** Substitute natural gas from coal using high-temperature reactor heat - Project 'Prototype Plant Nuclear Process Heat' ('Synthetisches Erdgas aus Kohle und Hochtemperaturreaktor-Wärme - Projekt 'Prototypenanlage Nukleare Prozesswärme'). E. Arndt (Hochtemperatur-Reaktorbau GmbH, Mannheim, West Germany), R. Fischer (Gesellschaft für Hochtemperaturreaktor-Technik mbH, Bergisch Gladbach, West Germany), W. Fröhling, I. Weisbrodt (Kernforschungsanlage Jülich GmbH, Jülich, West Germany), H. Jüntgen (Bergbau-Forschung GmbH, Essen, West Germany), and H. Teggers (Rheinische Braunkohlenwerke AG, Cologne, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie*, vol. 32, Jan. 1979, p. 17-23. 7 refs. In German. Research supported by the Bundesministerium für Forschung und Technologie.

The considered project is concerned with the further development of the processes for the transformation of solid fossil fuels on the basis of a use of heat from high-temperature reactors. Designs which are suitable for the construction of a prototype plant for an operational study of these processes are also to be obtained. The development of nuclear coal gasification takes place in several steps. The first steps are related to the design of suitable gasification procedures on a laboratory-scale basis, the design and operations of medium-scale experimental equipment for the selected gasification procedures, and studies concerning the design of large-scale installations for nuclear coal gasification. Details regarding the design of large-scale installations are discussed. Attention is also given to research and development work concerning the gasification technologies and the high-temperature reactor.

G.R.

**A79-23828** Gasification of coal with high-temperature reactor heat - Investigations concerning the market and the economics ('Vergasung von Kohle mit Hochtemperaturreaktor-Wärme - Markt- und Wirtschaftlichkeitsuntersuchungen'). H. Bialusiewski (Rheinische Braunkohlenwerke AG, Cologne, West Germany), K. H. Bode (Hochtemperatur-Reaktorbau GmbH, Mannheim, West Germany), L. Hardt (Bergbau-Forschung GmbH, Essen, West Germany), G. Joswig, H. J. Neef (Kernforschungsanlage Jülich GmbH, Jülich, West Germany), and H. W. Schmitz (Gesellschaft für Hochtemperaturreaktor-Technik mbH, Bergisch Gladbach, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie*, vol. 32, Jan. 1979, p. 24-26. In German. Research supported by the Bundesministerium für Forschung und Technologie.

The combination of coal and nuclear energy represents for West Germany an approach for the substitution of imported energy carriers which are more and more in short supply. The gasification of coal to substitute natural gas (SNG), in particular, provides a product for which the existing distribution and consumption structure of the natural gas can be largely utilized without a need for major additional investments. An analysis of the thermal energy market in West Germany was conducted to obtain an estimate regarding the employment potential of SNG. Production costs of SNG are compared with prices for fuel oil and natural gas, taking into account

data for installations starting operations in 1976 and in the year 2000. It is found that the costs for SNG obtained from lignite is significantly lower than the costs for SNG obtained from other types of coal. Nuclear gasification is significantly more economical than autothermal gasification. Costs for SNG obtained in the year 2000 from lignite by means of nuclear gasification are lower than estimated costs of fuel oil and natural gas in the same year. G.R.

**A79-23829** Methane formation during the hydrogasification and the gas phase pyrolysis of defined aromatics (Methanbildung bei Wasserstoff vergasung und Gasphasenpyrolyse definierter Aromaten). W.-D. Gräber and K. J. Hütinger (Karlsruhe, Universität, Karlsruhe, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie*, vol. 32, Jan. 1979, p. 26-31. 31 refs. In German. Research supported by the Deutsche Forschungsmeinschaft.

Advantages regarding a production of substitute natural gas from coal are related to the high calorific value of methane and the possibility to utilize existing supply and distribution installations for natural gas. The reported investigation is concerned with problems related to the methane formation process. Aromatics used in a number of experiments include benzene, naphthalene, 1-methyl naphthalene, 2-methyl naphthalene, and diphenyl methane. Reaction temperatures in the range from 600 to 1000 C were used. In the case of benzene and naphthalene noticeable methane formation was first observed at temperatures in the range from 850 to 900 C. The formation of methane in the case of 1-methyl naphthalene, 2-methyl naphthalene, and diphenyl methane begins already at temperatures in the range from 600 to 700 C. G.R.

**A79-23830** Oil shale in the U.S. - Current state of technology and research (Ölschiefer in den USA - Stand der Technik und Forschung). H.-H. Schmitz (Bundesanstalt für Geowissenschaften und Rohstoffe, Hanover, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie*, vol. 32, Jan. 1979, p. 31-34. In German.

Programs have been undertaken by agencies of the U.S. Government with the objective to develop and demonstrate technologies for obtaining energy from oil shale by means of economical, operationally reliable, and environmentally acceptable approaches. Data for economically feasible methods are to be obtained until 1980. The results of the investigations, which are funded by the U.S. Government, are to be made available to private industry. A description is presented of the main research institutes which are engaged in the programs of the U.S. Government concerned with oil shale, taking into account the Laramie Research Center, the Lawrence Livermore Laboratory, the Sandia Laboratories, and the Los Alamos Scientific Laboratory. Attention is also given to the activities of private firms and the current economical situation. G.R.

**A79-23832** Hot dry rock - A new potential for energy. R. A. Pettitt (California, University, Los Alamos, N. Mex.). *Geothermal Energy*, vol. 6, Nov. 1978, p. 11-19. 16 refs.

The technology for exploiting hot dry rock (HDR) energy is discussed with attention to the development work by the Los Alamos Scientific Laboratory (LASL). The concept of a man-made geothermal reservoir where conventional hydraulic fracturing techniques are used is described, noting that after forming a circulation loop by drilling a second hole into the top of the fracture region, the heat contained in the reservoir is convected to the surface by pumping. The drilling techniques (to depths of over 9600 ft) for the holes GT-2 and EE-1 at Fenton Hill (New Mexico) are also described, with the results of the flow testing in 1978 showing that thermal contraction and pore fluid pressurization may have enlarged the accessible volume of rock considerably. Future flow tests will be aimed at further characterization of the fractured reservoir, and it is projected that in 1979 the Fenton Hill system will be expanded by drilling to 12,000 ft where temperatures of 250 C are expected. The first demonstrations of the use of geothermal energy might be possible by 1985. A.A.

**A79-23867** Solar-cell panel simulator. D. Baert (Gent, Rijksuniversiteit, Ghent, Belgium). *Electronics Letters*, vol. 15, Jan. 18, 1979, p. 53, 54.

The energy generated by solar cells can be transformed into ac power by means of inverters. In most cases these inverters cannot be tested under real conditions, since large solar-cell arrays are not yet available at reasonable prices. Therefore, a circuit that simulates a solar-cell array has been developed. (Author)

**A79-23975** Winglets give USAF KC-135 new look in life. *Aviation Engineering and Maintenance*, vol. 3, Jan. 1979, p. 24-26.

The function of the winglets, projected to be installed at the end of the KC-135 wings, and currently under testing at the Air Force Flight Development Laboratory, is described, together with a presentation of some technical aspects involving the installment. The use of the winglets is expected to improve range and fuel consumption by about 6% and enhance the overall operational capabilities of the aircraft. Tests have shown though that the winglets have a torquing effect on the aircraft wing, requiring thus modifications on the wing. The final series of flight tests will take place in the early 1980's. A.A.

**A79-24037** Electron cyclotron heating in high density toroidal plasmas. T. Maekawa, S. Tanaka, Y. Hamada, and Y. Terumichi (Kyoto University, Kyoto, Japan). *Physics Letters*, vol. 69A, Jan. 22, 1979, p. 414-416. 6 refs.

A theoretical analysis is presented of wave trajectories of ordinary and extraordinary modes injected obliquely into the magnetic fields of high-density toroidal plasmas. It is found that both the O mode injected from outside the torus and the X mode injected from inside are converted into Bernstein waves which propagate toward the center of the plasma column and are cyclotron-damped, resulting in local electron heating. The effect of the rotational transform on the Bernstein wave is pronounced. B.J.

**A79-24040** Weak points of our prediction models for raw materials strategy (Schwachstellen unserer rohstoffstrategischen Prognosemodelle). K. H. Schmid (Siemens AG, Munich, West Germany). *Metall*, vol. 33, Feb. 1979, p. 193-196. 22 refs. In German.

It is argued that the recovery of production process waste materials and the recovery of scrap material will not, under realistic assumptions, contribute a significant amount to the covering of future needs in various industrial materials. Possibilities for estimating scrap metal potential are pointed out. Various optimistic estimates of energy savings by secondary material recovery are refuted. P.T.H.

**A79-24045** Solar energy storage as hydrogen and bromine from hydrogen bromide. E. A. Fletcher (Minnesota, University, Minneapolis, Minn.). *Energy (UK)*, vol. 4, Feb. 1979, p. 61-66. 14 refs.

The use of hydrogen bromide as the working fluid for a one-step thermochemical solar energy storage device is considered. When dissociation of Br<sub>2</sub> into Br at moderately high temperatures is taken into account, the system becomes one in which high-temperature separation of hydrogen from bromine in one step appears attractive. (Author)

**A79-24046** Geothermal energy in Imperial County, California - Environmental, socio-economic, demographic, and public opinion research conclusions and policy recommendations. M. J. Pasqualetti (Arizona State University, Tempe, Ariz.), J. B. Pick, and E. W. Butler (California, University, La Jolla, Calif.). *Energy (UK)*, vol. 4, Feb. 1979, p. 67-80. 40 refs. NSF Grant No. AER-75-08693.

**A79-24047** Industrial cogeneration - Problems and promise. L. Iceman and D. M. Staples (Washington University, St. Louis, Mo.). *Energy (UK)*, vol. 4, Feb. 1979, p. 101-117. 46 refs. Research sponsored by the Missouri Department of Natural Resources.

## A79-24048

Considerable potential for industrial cogeneration of electricity and process heat is currently available in the U.S. A number of prime mover technologies suitable for application in cogeneration facilities are already technically proven in other conventional systems. Industries with particularly attractive opportunities include paper and pulp, chemical, petroleum refining, iron and steel, and cement manufacturers. The apparent technical potential is limited significantly by economic, environmental, and regulatory factors, as well as by the need for new dimensions in industry and utility cooperation. Although substantial societal benefits in the form of energy conservation are available from a strong commitment to industrial cogeneration systems, many obstacles to systems deployment remain, which will not be readily overcome without the adoption of policy incentives.

(Author)

**A79-24048 Cost-effectiveness of the vortex-augmented wind turbine.** O. Igry (Negev, University, Beersheba, Israel). *Energy* (UK), vol. 4, Feb. 1979, p. 119-130. 20 refs.

Cost estimates for the conventional, horizontal-axis, wind turbine and for the vortex-augmented wind turbine are presented. For the latter, the vortex is generated by an appropriate delta wing. It is shown that the vortex-augmented wind turbine competes well with the conventional type. Its economical advantage increases with increasing output power.

(Author)

**A79-24137 Failure analysis in coal conversion systems.** R. T. King (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: *Materials synergisms; Proceedings of the Tenth National Technical Conference*, Kiamesha Lake, N.Y., October 17-19, 1978.

Asusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 792-801. 5 refs. Contract No. W-7405-eng-26.

The paper is concerned with causes of material failures in pilot plants for coal conversion to alternate fuels. Examination of a coal liquefaction plant dissolver tank and related fittings as well as the analysis of atmospheric fluidized bed combustor air distributor plates are described. The range of tests required to identify material failures in plant components is considered.

M.L.

**A79-24138 Encapsulant materials for \$2/watt terrestrial photovoltaic arrays.** H. Maxwell (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: *Materials synergisms; Proceedings of the Tenth National Technical Conference*, Kiamesha Lake, N.Y., October 17-19, 1978.

Asusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 812-823. 9 refs.

Materials properties, cost data, and strawman designs are presented relative to materials for \$2/watt terrestrial photovoltaic arrays to meet LSA Project cost goals for 1982. It is shown that encapsulation materials can be categorized in six basic elements: top covers, super-strates, pottants, adhesives, substrates, and bottom covers. The roles of the six basic encapsulant material elements in the encapsulant system are discussed and candidate materials presented.

(Author)

**A79-24151 Risk with energy from conventional and non-conventional sources.** H. Inhaber. *Science*, vol. 203, Feb. 23, 1979, p. 718-723. 18 refs.

Risk to human health was compared for five conventional and six nonconventional energy systems, and it is concluded that, in terms of the risk per unit energy, the risk from nonconventional sources can be as high as, or even higher than, that of conventional sources. The conventional sources considered are coal, oil, nuclear, natural gas, and hydroelectricity, while the nonconventional sources are wind, methanol, solar space heating, solar thermal, solar photovoltaic, and ocean thermal. The risk from nonconventional sources is attributed to the large amount of material and labor required for utilization of the source as well as to backup and storage requirements.

M.L.

**A79-24239 The geothermal power station at Ahuachapan, El Salvador.** R. DiPippo. *Geothermal Energy*, vol. 6, Oct. 1978, p. 11-22. 7 refs. Contract No. EY-76-5-02-4051-A001.

The geothermal power station at Ahuachapan (El Salvador) is described, together with information on the reservoir characteristics and well programs. Consideration is given to the geofluid collection and transmission system consisting of a 14 in. control valve, through which the two-phase geofluid passes, a cyclone separator with a capacity of 350 Mg/h, a vertical hot water collecting tank, two vertical silencers for flashing the liquid to atmospheric conditions, and four reinjection wells. The energy conversion system is particularly noted, indicating that it consists of an auxiliary turbo-generator unit, used for station start-up from cold conditions, and two main power units, each employing a double-flow turbine with impulse-reaction blading, and developing 30 MW. It is concluded that the experience at Ahuachapan has shown that a liquid-dominated resource of moderate salinity (18,400 PPM) and relatively high temperature (230 C bottomhole) can provide electricity in an economical and reliable manner.

A.A.

**A79-24240 Soil cooling for geothermal electric power plants in the Western United States - The Raft River experiment.** N. E. Stanley, D. L. Siegel, and W. D. Gertsch (EG & G Idaho, Inc., Idaho National Engineering Laboratory, Idaho Falls, Idaho). *Geothermal Energy*, vol. 6, Oct. 1978, p. 23-25. 7 refs.

**A79-24275 Tropospheric conduits.** C. E. Kaempen (Kaempen Industries, Inc., Orange, Calif.). *Energy Communications*, vol. 4, no. 6, 1978, p. 499-507.

Structure, use, cost, and performance of tropospheric conduits are described. A tropospheric conduit is essentially a vertical tube which connects lower portions of the troposphere with its upper portions having different temperatures and pressures, with the typical structure consisting of an aerostatically supported conduit measuring 100 m in diam and 2000 m in height, and large circular rooms at the lower portion. Electrical energy is generated by an air tubing system, and if a typical system is located where a lapse rate of 23 C is possible to attain, it will produce approximately 100 MW of electrical energy. The system could also produce about 80 million liters of fresh water each day if it were located where inlet air at ground level contains 5 g of water vapor per cu m of air. Further, it can remove as much as 13 million cu m of polluted air every minute. Tropospheric conduit systems could be constructed in less than five years for a total cost of about \$100,000,000 each, taking advantage of the progress done with plastic materials.

A.A.

**A79-24309 Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978.** Meeting sponsored by the American Society of Mechanical Engineers. Edited by J. M. Nash, J. T. Smok (IBM Corp., Federal Systems Div., Gaithersburg, Md.), W. C. Thomas (Virginia Polytechnic Institute and State University, Blacksburg, Va.), and P. E. Jenkins (Texas A & M University, College Station, Tex.). New York, American Society of Mechanical Engineers, 1978. 105 p. Members, \$9.00; nonmembers, \$18.

Methods of modeling and simulating solar energy systems are presented and applied to various types of systems. Topics studied include a modular approach to solar system modeling with generalized programs for working fluid properties, study of effects of low solar input and storage amount on thermosyphon hot water system performance, optimization of passive solar characteristics of buildings, a model of a liquid solar energy storage tank, and a study of the effects of test fluid, flow rate, and flow regime on solar collector thermal performance.

P.T.H.

**A79-24310 # Solar system modeling using a modular approach with generalized programs for working fluid properties.** T. C. Scott (Virginia, University, Charlottesville, Va.). In: *Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December*

10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 1-13. 31 refs.

A technique of efficiently modeling solar energy systems for computer simulation is described. The technique is based on a modular approach and allows one to rapidly create simple models having a wide range of flexibility. Such models are extremely useful during the initial feasibility study phase when a large number of possible system configurations must be examined. The structure of a library of computer programs for the evaluation of the thermo-physical properties of fluids is also described. Such a library is necessary as a supporting tool for the analysis of many thermo-fluids problems and greatly simplifies the task of modeling solar energy systems. The value of the modeling method and the properties library is illustrated by applying them to the initial study of a Rankine cycle assisted vapor compression refrigeration unit. The purpose is to show how one can gain a large amount of information from simple models through the use of this technique. (Author)

**A79-24311 # The effects of internal latent energy storage on the operational dynamics of a solar-powered absorption cycle.** A. W. Harris (General Electric Co., Schenectady, N.Y.) and C. N. Shen (Rensselaer Polytechnic Institute, Troy, N.Y.). In: Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 15-24. 12 refs.

A system diagram and performance equations are presented for a solar-powered absorption cycle heat pump system utilizing latent energy storages internal to the absorption cycle itself. A water-lithium bromide absorption cycle heat pump directly coupled to a flat plate solar collector is considered. Generalized weather functions are used to represent insolation and heating/cooling load inputs to the model. All collected solar energy is utilized in generating stored refrigerant by means of control of refrigerant-absorbent mixture flow to the generator. An operational algorithm to maximize the production of stored refrigerant as a function of solar energy intensity is shown. The relative operational independent of the collector/generator/condenser from the load demand/evaporator/absorber is emphasized. Comparisons are made between the diurnal operation of the solar-powered internal latent energy storage absorption cycle heat pump system and one having an external sensible heat storage between collector and absorption cycle generator. These comparisons show that auxiliary energy requirements are greatly reduced by introducing the internal latent energy storages. (Author)

**A79-24312 # Effects of low solar input and amount of storage on thermosyphon hot water system performance.** D. A. Dougherty (General Electric Co., Nuclear Energy Engineering Div., San Jose, Calif.) and J. W. Baughn (California, University, Davis, Calif.). In: Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 25-31. 9 refs.

The response of a flat-plate solar water heating system operating with natural circulation (thermosyphon) to marginal solar radiation and the effect of the amount of storage per unit collector area have been investigated using an analytical model. The model has been verified previously by comparison with measurements taken on an experimental system. Increasing the amount of storage was found to increase the instantaneous and accumulated efficiencies of the system, but at a loss in average storage temperature. On days of marginal solar input, the thermosyphon system was found to perform as well as pumped systems, even as well as pumped systems having thermostatic controls. Pumped systems may increase or decrease the amount of thermal stratification in the storage tank, but do not change the system efficiencies significantly, except with very low flow rates, which may cause appreciable efficiency losses. (Author)

**A79-24313 # A computer simulation model for determining preferred solar heating and cooling systems.** R. L. Merriam, D.

Nathanson, and P. M. O'Farrell (Arthur D. Little, Inc., Cambridge, Mass.). In: Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 33-42. Research supported by the Electric Power Research Institute.

A 'preferred' solar heating system is understood in this paper to mean one that minimizes the total cost of meeting the energy needs of an application, where the supply cost to the electric utility, and not the utility rate, is taken into account. A computer model is developed for determining a preferred solar heating system. The model simulates the transient thermal behavior of the building and the heating, ventilating, and air conditioning (HVAC) equipment. From the input data, energy balance coupling equations are automatically constructed within the program and are solved at each time step. User-defined control functions determine the interrelationships among system elements and when the various components are activated. Actual weather data are used, and the dynamic behavior of the HVAC system is simulated in response to the hourly building heating and cooling loads. The outputs give descriptions of the technical performance of the house and HVAC system, and provide a breakdown showing various components of the utility's costs. P.T.H.

**A79-24314 # A liquid solar energy storage tank model. I - Formulation of a mathematical model.** S. T. Wu and S. M. Han (Alabama, University, Huntsville, Ala.). In: Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 53-60. 12 refs. Contract No. EG-77-S-02-4479.

A one-dimensional model of the liquid energy storage tank, which is compatible with TRNSYS, was formulated as an initial-boundary value problem. Resulting governing equations were then numerically solved by the Crank-Nicolson finite difference method. The numerical results were compared with existing experimental data and other available models to show that the present model produced better agreements with the experimental results. Advantages of the present model are: (1) simplicity in mathematical expression of the model, (2) explicit appearance of all important parameters associated with thermal stratification, (3) capability of representing realistic thermocline, and (4) the effects of an internal heat exchanger inside the storage tank can be easily incorporated. (Author)

**A79-24315 # Solar energy for industrial process steam.** S. B. Youngsblood, D. M. Bell, and D. F. Brink (Acurex Corp., Mountain View, Calif.). In: Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 61-71.

The analysis and design of a solar energy system that will supply 446 K steam to a gauze-bleaching process is summarized. As part of a program for the Department of Energy, the system will demonstrate the technical and economic feasibility of generating low-pressure steam (saturated, 373 to 450 K) with solar energy for industrial processes. The resulting design consists of 1,070 sq m of line-focusing parabolic trough concentrators that will supply approximately 60 percent of the annual process energy demand. (Author)

**A79-24316 # The cryogenic heat transfer tunnel - A new tool for convective research.** A. M. Clausing, C. L. Clark, and M. H. Mueller (Illinois, University, Urbana, Ill.). In: Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 73-78. Research supported by the U.S. Department of Energy.

A novel heat transfer technique, the use of cryogenic temperatures for convective modeling, is used in this study in order to simultaneously obtain large Grashof and Reynolds numbers on a

vertical cylinder. The research is motivated by the need to predict combined convective losses from large, high-temperature objects such as solar 'power tower' receivers where the magnitudes of both the Grashof and Reynolds numbers are large. The cryogenic heat transfer tunnel provides an economical method of obtaining these large Grashof and Reynolds numbers with an appropriate and nearly constant Prandtl number; thus it is an excellent tool for study of convective heat transfer. Low-temperature modeling, a cryogenic testing facility, and a transient measurement technique are discussed.

(Author)

**A79-24317 # Effects of test fluid, flow rate, and flow regime on solar collector thermal performance measurements.** W. C. Thomas (Virginia Polytechnic Institute and State University, Blacksburg, Va.). In: Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 85-89. 8 refs.

The effects of test fluid parameters on measured collector efficiency were investigated. An analytical thermal performance model was validated by experimental results and then used to carry out parametric studies. Test fluid composition, flow rate, and flow regime were shown to have a significant effect on collector efficiency. Certain combinations of fluid composition and flow rate result in laminar-to-turbulent transition. The effects on efficiency attributable to the test fluid parameters were compared with effects expected to result from variations in the test environment. It was shown that wind and the scattered fraction of radiation can have strong effects on measured efficiency. P.T.H.

**A79-24321 Solar energy and heat insulation (Sonnenenergie und Wärmedämmung).** H. Völker. *Sonnenenergie*, vol. 3, Nov.-Dec. 1978, p. 7, 8. In German.

It is pointed out that for optimal residential solar energy systems it will not be necessary to seek new ways of heat insulation but merely to increase the thickness of conventional insulation. Recommendations on the dimensioning of insulation consisting of mineral fibers or polystyrol materials for a typical house are given. Insulation requirements of the collector and storage units are also discussed. P.T.H.

**A79-24322 Solar storage unit with built-in oil-gas boiler (Solarspeicher mit eingebautem Öl-Gas-Kessel).** O. Schuster. *Sonnenenergie*, vol. 3, Nov.-Dec. 1978, p. 11-13. In German.

The paper describes a hybrid boiler-solar-storage combination with integrated control of the solar-boiler heating cycle. Heat loss from the boiler is absorbed by a two-zone storage unit that nearly surrounds the boiler. During the summer, the boiler is used only when the total solar radiation is insufficient to provide the required amount of hot water. Data from thirty days of summer operation of the system are presented. P.T.H.

**A79-24323 Stormy development of wind energy (Stürmische Entwicklung der Windenergie).** A. Jarass and L. Jarass. *Sonnenenergie*, vol. 3, Nov.-Dec. 1978, p. 14-17. 10 refs. In German. Bundesministerium für Forschung und Technologie Contract No. ET-4085-A.

The meteorological and topographical considerations for wind energy are briefly reviewed, and the potential contribution of wind energy to the energy picture in the Federal Republic of Germany is assessed. On the northern German coast the average wind speed exceeds what has been calculated as the minimum required for economically viable wind power production. There are still insufficient measurements for inland regions at the required hub heights. Several problems with regard to large-scale installations are not yet solved: (1) the need for nonfatiguing material for the rotors, (2) complex vibration behavior of the rotor-nacelle-tower system, and (3) speed-switching systems with reliable stormproofing. Surprisingly, the relation between annual energy production and annual average wind speed is roughly linear for the Growian installation, despite

the fact that kinetic energy of wind increases with the third power of wind speed. Calculations show that 1500 Growian devices would cover about 31% of the northern German electricity needs for 1977.

P.T.H.

**A79-24450 Space will be the next big construction site.** G. Bylinsky. *Fortune*, vol. 99, Feb. 26, 1979, p. 62-65, 68.

Further space constructions planned by NASA are described with particular attention to batteries of antennas, called antenna farms, and solar-power satellites. An antenna farm will consist of a metal skeleton about 700 ft long, housing as many as thirty large dish antennae, accomodating up to five nationwide television channels, and serving almost 45,000 private channels handling calls from millions of pocket telephones. The projected solar-power satellite will be capable of feeding ten megawatts of electricity into its own antenna where it will be transformed into microwaves and beamed back to earth. The construction materials will be ferried by the Shuttle.

A.A.

**A79-24486 Design of a heat pipe with separate channels for vapor and liquid.** Iu. E. Dolgirev, Iu. F. Gerasimov, Iu. F. Maidanik, and V. M. Kiseev (Ural'skii Politekhnicheskii Institut, Sverdlovsk, USSR). (*Inzhenerno-Fizicheskii Zhurnal*, vol. 34, June 1978, p. 988-993.) *Journal of Engineering Physics*, vol. 34, no. 6, Dec. 1978, p. 661-665. Translation.

The heat transfer capacity and operating conditions of an antigravity heat pipe, with separate ducts for vapor and liquid, operating in evaporation regime, are calculated. The initial data for the calculation are the height of the heat pipe, geometric dimensions, characteristics of the capillary-porous structure of the pipe, and the temperature of the vapor and condensate arriving at the feed. The temperature drop at the barrier wall of the wick is determined and the condition for nonboiling of the liquid in the equalizing gap is verified. The dependence of heat pipe operation on temperature drop at the barrier wall of the wick,  $dP/dT$  of the heat carrier at a given temperature, and hydraulic resistance of the outer circuit is determined. Computer calculations<sup>3</sup> for a specific heat pipe were performed, and agreement with experimental data was good. P.T.H.

**A79-24507 # Storage peak gas-turbine power plant (Akumuliruiushchaya pikoavaia gazoturbinnaya ustankovka).** B. Tsinkotski (Budapesti Muszaki Egyetem, Budapest, Hungary). *Periodica Polytechnica, Mechanical Engineering*, vol. 22, no. 2, 1978, p. 95-113. 5 refs.

A storage gas-turbine power plant using a two-cylinder compressor with intermediate cooling is studied. On the basis of measured characteristics of a 25 MW compressor, computer calculations of the parameters of the loading process of a constant capacity storage unit (0.5-3 million cu m) were carried out. The required compressor power as a function of time with and without final cooling was computed. Parameters of maximal loading and discharging of the storage unit were calculated, and it was found that for complete loading of a fully unloaded storage unit, a capacity of 1-1.5 million cu m is required, depending on the final cooling. P.T.H.

**A79-24508 # A digital control system for superconducting magnet.** M. Hirano, Y. Murakami, E. Ito, and M. Nishimura (Osaka University, Osaka, Japan). *Osaka University, Technology Reports*, vol. 28, Oct. 1978, p. 401-409. 5 refs.

An inductor-converter unit which consists of a Graetz-type six-pulse converter and a solenoid superconducting magnet has been developed. A microcomputer-based controller and its input/output interfaces have also been constructed for the control system. The closed-loop control is performed through the following operations: detection of the circuit current, comparison with the reference input for generating the error signal, determination of the firing angle by PID compensation and the arc cosine correction, and generation of trigger pulses. These operations are performed by the program instructions of the microcomputer. The pattern of reference input and PID constants is given through the keyboard of the teletypewriter. These system organizations and the open-loop and close-loop system performances are described.

(Author)

**A79-24539 #** On the dynamics of wave-power devices. B. M. Count (Central Electricity Generating Board, Marchwood, Hants., England). *Royal Society (London), Proceedings, Series A - Mathematical and Physical Sciences*, vol. 363, no. 1715, Nov. 27, 1978, p. 559-579. 17 refs.

The theory of ship dynamics is used to study the performance of a class of wave-power devices. Results are presented for two different devices and a comparison is made between them. The Salter duck and a two-pontoon system, semieliptical in cross section and hinged at its center, constrained to move only in the mode in which energy is absorbed, appear to be equivalent. Both structures are designed so that when forced to move in their absorbing mode they generate waves in one preferred direction, the pontoon design relying on the use of a shallow horizontal breakwater in the rear of the moving structure, while the Salter device uses a shorter, deeper structure which looks almost cylindrical. B.J.

**A79-24611** Electric vehicle progress in the U.S. - Where to. G. Greenberg. *Energy*, vol. 4, Winter 1979, p. 7-9, 13.

The state of the electric vehicle industry in the United States is reviewed, focusing on government efforts to promote development. A demonstration program using up to 7500 vehicles by 1984 and intended to identify specific markets where electric and hybrid vehicles can be introduced and accepted is detailed, and government contracts and incentive loans for electric vehicles noted. A government assessment of electric and hybrid vehicle technology is being conducted based on operational data derived from demonstration project vehicles, as well as commercially available vehicles, in order to improve state-of-the-art components. Ongoing research on electric batteries, mechanical energy storage systems and propulsion systems by government and private industries is outlined, noting however that small manufacturers are still the major force in the industry. A.L.W.

**A79-24612** Wind energy - The long road to commercialization. L. A. Braunstein. *Energy*, vol. 4, Winter 1979, p. 10, 11, 20.

Various programs of wind energy research are examined and their potential for commercial development is evaluated. The Department of Energy (DOE) is testing a variety of small wind-powered machines at its Colorado facility and small-to-medium sized machines in farm applications at other sites. Large-scale wind turbines are also being developed as electric power generators. Most of DOE's large turbines are horizontal axis machines, however the vertical axis design, which accepts wind from any direction, is also being investigated. Although studies have shown an economy of scale for large wind machines, small systems are considered economical in remote regions. At present, wind-derived electricity costs (15 cents per kWhr for small machines and from 10 to 20 cents per kWhr for large turbines) are not competitive with utility-produced power costs (4 to 6 cents per kWhr) and efforts are being made to reduce costs according to DOE goals. Wind energy though is approaching commercialization and appears capable of reaching cost goals sooner than photovoltaic or solar thermal power systems. A.L.W.

**A79-24620** Continental geotherms during the Archaean. P. C. England (Cambridge University, Cambridge, England). *Nature*, vol. 277, Feb. 15, 1979, p. 556-558. 13 refs.

It is found that P-T data from high grade Archaean terrains represent temperatures reached during the exhumation of the rocks from an overthick crust and are probably not lower than equilibrium profiles for this thickened crust. At present the best upper limit which may be placed on the heat flow from the Archaean mantle from these data is 2-3 times present-day subcontinental values, and in this respect the P-T data offer no improvement in constraints of Archaean geothermal regimes over those from general observations of continental integrity in the Archaean. It would be possible to lower the upper bound on Archaean continental geothermal gradients if reliable information were obtained on the distribution of heat-producing elements in the Archaean crust and on the P-T-time paths followed during the exhumation of high grade Archaean rocks. G.R.

**A79-24621** Use of organic fluids in solar turbines (L'emploi des fluides organiques dans les turbines solaires). A. Verneau (Société Bertin et Cie., Paris, France). *Entropie*, vol. 14, no. 82, 1978, p. 9-18. In French.

The paper discusses theory and experiments on the use of a Rankine cycle engine with organic fluid vapor, where the temperature of the heat source is in the moderate range 150-300 C, in solar electric power plants. The effect of different fluid parameters on the turbine design is studied. Work on a prototype 350 kW system based on FC75 fluid, axial single-stage turbine with rotation speed of 3000 rev/min with total injection, feed temperature of 235 C, pressure ratio of 133, and 75 percent efficiency, is described. P.T.H.

**A79-24622** Medium-power /100-1000 kW<sub>e</sub>/ solar power plants using distributed collectors (Les centrales solaires de moyenne puissance à collecteurs distribués 100 à 1 000 kW<sub>e</sub>). J.-L. Boy-Marcotte (Société Bertin et Cie., Paris, France). *Entropie*, vol. 14, no. 82, 1978, p. 19-25. In French.

Work on a prototype medium power solar power plant involved design, construction, and testing of solar collectors, storage, and organic fluid turbo-alternator. An optimization plan was carried out to reduce the cost of the electric power produced. The ratio of delivered electric power to incident solar energy was between 9 and 10 percent. The result of the study is a medium temperature heat generator that may find application in the production of industrial heat in the range 100-250 C. P.T.H.

**A79-24623** Current status and prospects for low-temperature solar energy (Réalisations et perspectives de l'énergie solaire à basse température). B. Devin (Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, Essonne, France). *Entropie*, vol. 14, no. 82, 1978, p. 26-31. In French.

The cost of low-temperature solar collection is examined, and possible ways in which the future costs will be reduced are mentioned. The storage problem for countries with a climate such as that of France is discussed. The growth of thermomechanical systems fed by solar energy is briefly outlined. The possibility of exporting low-temperature solar energy to developing countries is pointed out. P.T.H.

**A79-24813** Stability criteria for current-driven drift wave eigenmodes. D. W. Ross and S. M. Mahajan (Texas, University, Austin, Tex.). *Physics of Fluids*, vol. 22, Feb. 1979, p. 294-300. 18 refs. Contract No. EY-77-C-05-4478.

Eigenmodes of current-driven collisionless electrostatic drift waves in a sheared magnetic field are reexamined in the light of the recent discovery that their non-current-driven counterparts are stable. Conditions for instability are determined from numerical finite difference and variational solutions of the slab model differential equation. It is found that three stringent conditions are required for instability: (1) very weak shear, (2) low ion temperature, and (3) very large parallel drift velocity. For  $L(n)/L(s) = 0.02$  and  $T(i)/T(e) = 0$ , the instability threshold is  $u(d)/c(s) = 0.85$ , where  $L(n)$  and  $L(s)$  are the density and shear scale lengths, respectively,  $u(d)$  is the drift velocity, and  $c(s)$  is the sound speed. For larger shear and finite ion temperature the critical drift velocity is even larger. It is concluded that drift wave fluctuations in tokamaks cannot be described in terms of these eigenmodes. (Author)

**A79-24814** Parametric decay of lower hybrid waves in a plasma - Effect of ion nonlinearity. V. K. Tripathi, C. S. Liu, and C. Grebogi (Maryland, University, College Park, Md.). *Physics of Fluids*, vol. 22, Feb. 1979, p. 301-309. 12 refs. Research supported by the University of Maryland, U.S. Department of Energy, U.S. Navy, Conselho Nacional de Desenvolvimento Científico e Tecnológico, and NSF.

By using a simple scheme for calculating ion nonlinear effects in guiding center coordinates, the contribution of ions in the coupling coefficients is calculated for various channels of parametric decay, quasi-mode decay, oscillating two-stream instability, and modula-

**A79-24817**

tional instability of a lower hybrid pump with finite wave vector in a homogeneous plasma. It is found that decay into quasi-modes and the oscillating two-stream instability are the most likely candidates in all regimes of density relevant to tokamaks. The nonlinear ion cyclotron damping has a growth rate comparable to nonlinear electron Landau damping, so efficient ion heating is expected. Parametric decay into ion cyclotron and Bernstein waves have comparable growth rates to quasi-modes for low values of the  $E \times B$  electron drift velocity to ion sound speed ratio. Decay into two lower hybrid waves is important in the low density region and only for nonuniform pump. Modulational instability is insignificant in the whole range of parameters. The contribution of ions is important only for the decay into ion Bernstein waves.

P.T.H.

**A79-24817** Microstability of a focused ion beam propagating through a z-pinch plasma. P. F. Ottinger, D. Mosher (U.S. Navy, Naval Research Laboratory, Washington, D.C.), and S. A. Goldstein (Science Applications, Inc., McLean, Va.). *Physics of Fluids*, vol. 22, Feb. 1979, p. 332-337. 10 refs. Research supported by the U.S. Department of Energy.

A beam-plasma system consisting of a focused light ion beam propagating through a z-pinch plasma is analyzed for microinstabilities. Two instabilities are discussed, one driven by the relative streaming between beam ions and electrons and the other driven by streaming between plasma ions and electrons. Conditions for stability of both modes are derived and are used to demonstrate that ion beams appropriate for use in a pellet fusion device can be propagated to the pellet through a z-pinch plasma without disruptive microturbulence.

(Author)

**A79-24827** Engine technology for production turbofan engines. B. Walsh. *Aviation Engineering and Maintenance*, vol. 3, Feb. 1979, p. 28-31.

Technologies sponsored by NASA for the improvement of the JT8D and JT9D turbofan engines used on commercial transports are discussed. The four concepts in progress for the JT8D engine are (1) the development of an abradable trenched HP compressor blade resulting in a tighter blade clearance and an increase in the compressor's efficiency, (2) the modification of the turbine blade, (3) the replacement of the single pass blade with a two-pass root discharge blade with lower cooling air flow, and (4) the introduction of an advanced composite, the Kevlar PMR. The concepts in progress for the JT9D are: the design of a 3.8 aspect ratio fan blade for modifying aerodynamic airfoil, modification of first and second stage outer air seal supports, and coating of vane platforms and seal with Zirconia/NiCoCrAlY spray. The new technologies are expected to provide fuel savings ranging from 0.8% to 1.5%.

A.A.

**A79-24852** Electrons of high perpendicular energy in the low-density regime of tokamaks. M. Bornatici (Pavia, Università, Pavia, Italy), F. Engelmann (EURATOM and Stichting voor Fundamenteel Onderzoek der Materie, Instituut voor Plasmafysica, Jutphaas, Netherlands), C. S. Liu, Y. Mok, and K. Papadopoulos (Maryland, University, College Park, Md.). In: *Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 7-28; Discussion, p. 29-31. 23 refs. Research supported by the Nederlandse Organisatie voor Zuiver-Wetenschappelijk Onderzoek and EURATOM.

**A79-24854** Non-thermal emission at the plasma frequency. G. Ramponi, P. Brossier, and I. Fidone (EURATOM and CNR, Laboratorio di Fisica del Plasma, Milan, Italy). In: *Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 41-47; Discussion, p. 48.

Spectra obtained on the TFR under experimental conditions where the emission at the harmonics of the central electron cyclotron frequency is close to thermal exhibit an anomalous peak at

a frequency below the central electron cyclotron frequency with an amplitude that can be as high as 40 times the blackbody level. This emission always occurs at the central electron plasma frequency. The peak intensity is maximum early in the discharge and decays with a time constant of the order of 100 msec. There is some correlation between the power emitted at the electron plasma frequency and the instantaneous runaway creation rate. These observations suggest the presence of suprathermal electrons during the active phase of emission of radiation. On the assumption that the distorted distribution function of the electrons in the direction of the confining magnetic field is unstable against electrostatic waves, a model for the process is developed, from which an estimate of the order of magnitude of the radiated energy flux is obtained.

P.T.H.

**A79-24855** Asymptotic theory of dissipative trapped electron mode overlapping many rational surfaces. A. Rogister and G. Hasselberg (EURATOM and Kernforschungsanlage Jülich GmbH, Institut für Plasma physik, Jülich, West Germany). In: *Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 49-59; Discussion, p. 59, 60. 6 refs.

The two-dimensional eigenvalue equation describing the dissipative trapped electron mode is solved exactly in the limit of the mode overlapping many rational surfaces by use of the Pogutse model for the magnetic field and the pitch angle collision operator. It is shown that the trapped electron contribution to the growth rate is decreased, with respect to the standard theory, by a factor of a certain order. Conditions under which marginal stability is obtained are derived.

P.T.H.

**A79-24858** Theory of anomalous transport due to electrostatic fluctuations. T. E. Stringer (EURATOM and U.K. Atomic Energy Authority, Culham Laboratory, Abingdon, Oxon, England). In: *Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 103-121; Discussion, p. 122-128. 24 refs.

Theories of cross-field transport due to low-frequency electrostatic instabilities of the drift wave type are reviewed. First, attention is given to quasilinear theory, which predicts particle and energy transport proportional to the wave amplitude squared. An estimate of the saturation level leads to a well-known estimate for the particle diffusion coefficient. The transport mechanism described by the quasilinear analysis is examined critically, and its relevance to anomalous transport in a confined plasma is discussed. Numerical simulation of the transport process is discussed by following particle motions in the self-consistent fields of one or more unstable modes. Comparison between theory and tokamak experiments is made, and it is found that measured anomalous transport is comparable to the upper limit on quasilinear transport. Measured fluctuations agree in most respects with the linear drift wave theory.

P.T.H.

**A79-24859** Quasi-linear theory of heat flow and diffusion in a tokamak. N. A. Krall and J. B. McBride (Science Applications, Inc., Laboratory for Applied Plasma Studies, La Jolla, Calif.). In: *Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977*. Oxford, Pergamon Press, Ltd., 1978, p. 129-142; Discussion, p. 143-147. 10 refs.

A formulation of transport theory, including cross-field thermal conductivity, is presented and applied to transport in tokamaks due to trapped-particle instabilities, in the quasi-linear stage. Ratios of ion heat conduction, convection, and turbulent heating to electron heat conduction, and ratios of electron heat convection and turbulent heating to electron heat conduction are presented for trapped-electron and trapped-ion modes.

(Author)

**A79-24862** Integral invariants and quasi-MHD nonlinear dissipation. E. Minardi (EURATOM and U.K. Atomic Energy Authority, Culham Laboratory, Abingdon, Oxon, England). In: *Plasma transport, heating and MHD theory; Proceedings of the*

Workshop, Varenna, Italy, September 12-16, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 179-187; Discussion, p. 187-189.

A Hamiltonian approach to the derivation of integral invariants for a slightly dissipative plasma is presented. Starting from the Hamiltonian of the system of interacting particles forming a magnetized toroidal plasma, one derives a helical invariant, which can be interpreted as a helical flux in the proper limit. The existence of this invariant follows from the helical symmetry of the basic unstable magnetic process. The existence of integral invariants of the Taylor type follows from the helical invariant and a straightforward application of Liouville's theorem. These invariants are applied to the formulation of a diffusion equation for the helical flux in the cylindrical limit. A significant result is that it appears possible for the collisions to induce quasi-MHD dissipative processes which can be very rapid as a result of nonlinear effects. P.T.H.

**A79-24863** MHD stability for a spherator with a purely poloidal magnetic field. T. Hellsten (Kungl. Tekniska Hogskolan, Stockholm, Sweden). In: Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 191-200; Discussion, p. 201. 9 refs. EURATOM-supported research.

A localized analysis of the stability of a spherator with a purely poloidal magnetic field against MHD modes is presented. It is assumed that the closed-line concept is physically relevant for both linear equilibria and toroidal equilibria. In order to obtain a pressure distribution which decreases rapidly outwards and satisfies the closed-line interchange criterion, it is suggested that the plasma boundary be situated close to a magnetic separatrix. However, for finite beta-values, perturbations other than interchange modes may become unstable. It is found that the current density must be limited for stable equilibria, and that the maximum current density decreases rapidly in the region close to the separatrix. P.T.H.

**A79-24864** RF-heating in stationary systems. A. D. Piliia (Akademii Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR). In: Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 205-207; Discussion, p. 208-212.

Some unsolved technical problems in the electron cyclotron resonance (ECR) and lower hybrid (LH) frequency regions are briefly mentioned. In tokamaks, an extraordinary mode launched from the outer side of the torus cannot reach the cyclotron resonance surface directly and must get around the cut-off. In low-density regions where the cyclotron resonance and upper hybrid are close together, strong absorption may occur. In real-size machines the polarization and propagation angle of the wave must be chosen carefully to avoid power absorption near the wall, but the familiar wave trajectory computations may have uncertainties in their interpretation. Two linear problems call for (1) further development of the theory of coupling between the slow wave system and the plasma, including the wave reflection and matrix boundary conditions, and (2) computation of the wave trajectories taking into account the two-dimensional toroidal effects. P.T.H.

**A79-24865** Lower hybrid resonance heating. H. Momota (Kyoto University, Kyoto, Japan). In: Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 213-221; Discussion, p. 221, 222. 9 refs.

Attention is called to several problems regarding linear phenomena of lower hybrid resonance heating in tokamaks. Some recent experimental results on coupling between launchers and the plasma, and on reflection of incident waves at the lower hybrid turning point, are discussed. Mechanisms of energy deposition from an applied wave are examined, and a simple model for lower hybrid resonant resonance is presented. P.T.H.

**A79-24866** Magneto-acoustic resonance heating in the ion-cyclotron frequency domain. R. R. Weynants (Koninklijke Militaire School; Nationale Fonds voor Wetenschappelijk Onderzoek, Brussels, Belgium), V. P. Bhatnagar, P. E. Vandenberg (Ecole Royale Militaire, Brussels, Belgium), and A. M. Messiaen (Ecole Royale Militaire; Fonds National de la Recherche Scientifique, Brussels, Belgium). In: Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 223-242. 14 refs.

With regard to the problem of heating toroidal plasmas, this paper presents a completely self-consistent calculation of the coupling of RF energy to magnetoacoustic resonances by means of coils. Simple but accurate formulas are obtained for the eigenfrequencies, coil impedance, coupling coefficients, and the absorbed power and energy. Indications are also given on how to evaluate the quality factor for various damping mechanisms in the plasma, including the mechanism due to the confluence of fast and slow waves near the ion-ion hybrid. P.T.H.

**A79-24867** Wave propagation and absorption near the electron-cyclotron layer in the 'THOR' device C. Maroli and M. Bornatici (EURATOM and CNR, Laboratorio di Fisica del Plasma, Milan, Italy). In: Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 243-258; Discussion, p. 259-261. 17 refs. Research supported by the Consiglio Nazionale delle Ricerche.

The paper investigates the propagation and absorption of the extraordinary mode in a plasma with parameters typical of the THOR device. The trajectories along which the injected power propagates are evaluated numerically for toroidal geometry. The spatial damping of the electron Bernstein mode generated by mode conversion of the extraordinary wave at the upper hybrid layer is then evaluated numerically for a slab with parabolic density profile and  $T(e) = 200$  eV for different values of the parallel refractive index. It is found that the lower the parallel refractive index, the nearer to the electron cyclotron layer is the site of absorption. P.T.H.

**A79-24879 #** Some perspectives on research into the biological response to non-ionizing electromagnetic radiation. J. C. Sharp (NASA, Ames Research Center, Moffett Field, Calif.). *Radio Science*, vol. 14, Jan.-Feb. 1979, p. 5-10.

Research on the biological effects of RF radiation in the United States has undergone a series of swings during the last three decades. The resurgence of research during the past decade is examined in the light of two projects: the proposed Space Power Station and SETI. B.J.

**A79-25060 #** Selected ordinates for total solar radiant property evaluation from spectral data. J. A. Wiebelt and J. B. Henderson (Oklahoma State University, Stillwater, Okla.). *ASME, Transactions, Journal of Heat Transfer*, vol. 101, Feb. 1979, p. 101-107. 8 refs.

The evaluation of the absorptance or transmittance of solar collector glazing materials requires knowledge of the spectral characteristics of solar irradiation (insolation). The present paper reexamines insolation at the earth's surface using the latest atmospheric data. A new and expanded set of selected ordinates is calculated. These ordinates are used to evaluate the total solar transmittance, or other related properties, for a wide variety of atmospheric conditions, from the spectral data. S.D.

**A79-25066 #** Radiant exchange for a fin and tube solar collector. T. F. Smith (Iowa University, Iowa City, Iowa) and H. Y. Lee. *ASME, Transactions, Journal of Heat Transfer*, vol. 101, Feb. 1979, p. 185-187. Research supported by the Iowa Energy Policy Council.

An analysis is presented to examine the radiant exchange phenomenon found in a fin and tube solar energy collector. It is shown that the collector efficiency depends on the tube spacing-to-

radius ratio, fin conductance, convective coefficient, absorbed solar energy, and air and surrounding surface temperatures which are used to calculate convective and radiative losses. The collector efficiency is found to increase with tube spacing and then decrease as a result of increased fin conductive resistance. Maximum collector efficiencies occur for tube spacing-to-radius ratios between 8 and 20. In particular, the efficiencies are sensitive to the values of air and surrounding surface temperatures.

S.D.

**A79-25069** Angle-of-incidence effects in electron-beam-deposited SnO<sub>2</sub>/Si solar cells. T. Feng, A. K. Ghosh, and C. Fishman (Exxon Research and Engineering Co., Linden, N.J.). *Applied Physics Letters*, vol. 34, Feb. 1, 1979, p. 198; 199. 5 refs. Contract No. E(04-3)-1283.

The power-conversion efficiency of SnO<sub>2</sub>/Si solar cells fabricated by electron-beam evaporation of SnO<sub>2</sub> is strongly dependent on the angle of incidence of the SnO<sub>2</sub> vapor stream on silicon. The optimum angle of incidence is between 50 and 70 deg. Solar cells with power-conversion efficiencies exceeding 10% have been reproducibly fabricated by depositing the SnO<sub>2</sub> at angles of incidence in this optimum range.

(Author)

**A79-25084** Heat exchanges and columnar growth in electron-beam evaporation of silicon films for solar cell applications. S. K. Dey, A. E. Delahoy, and W. A. Anderson (Rutgers University, Piscataway, N.J.). *Journal of Vacuum Science and Technology*, vol. 15, Sept.-Oct. 1978, p. 1739-1745. 22 refs. NSF Grant No. AER-73-03197.

Heat exchanges in electron-beam evaporation of polycrystalline Si films are studied for the first time using an electrical model. The analysis is useful for evaluating the growth kinetics of the film which influence the diameter of the columnar structure. It is shown that Si deposition causes an unsteady thermal state resulting from the radiative interaction of the substrate with the source and adjoining system parts. The calculated values of the heat exchange rates between source, substrate and enclosure, and the temperature gradient along the substrate, are in reasonable agreement with the measured parameters. Columnar films up to 27 microns in thickness, 6 microns in column diameter, and with 110-line-type preferred orientation, have been produced by e-beam deposition of Si on Al-coated substrates at temperatures ranging from 400 to 600 C. SEM micrographs are included showing columnar structure, effects of etching, and previously unreported growth features and the dependence of the column axis on the direction of the vapor stream.

(Author)

**A79-25124** Evaluation of commercial catalysts for the Fischer-Tropsch reaction. W. G. Borghard and C. O. Bennett (Connecticut, University, Storrs, Conn.). *I & EC - Industrial and Engineering Chemistry, Product Research and Development*, vol. 18, Mar. 1979, p. 18-26. 21 refs. Research supported by the Electric Power Research Institute.

The hydrogenation of carbon monoxide was investigated at 20 atm (2.0 MPa) and 250 C (523 K) in tubular reactors. Four commercial iron catalysts, one commercial cobalt catalyst, and an iron lathe turning catalyst were tested at three hydrogen to carbon monoxide feed ratios. At a relatively constant space velocity the overall rates of reaction gave a good indication of activity. The cobalt catalyst appeared to be the best. Its selectivity favored saturated hydrocarbons. A nitrided ammonia synthesis catalyst attained a similar activity. An optimal feed ratio of 2:1 H<sub>2</sub>/CO was observed. The highest activities concurred with a 2:1 feed ratio and the production of water.

(Author)

**A79-25138** Enhanced power generation by optical solar reflectors on geostationary spinners. P. R. K. Chetty and R. M. Vasagam (Indian Space Research Organization, Satellite Centre, Bangalore, India). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-15, Jan. 1979, p. 119-124.

A novel arrangement is proposed to enhance the power generating capabilities of a spin stabilized geostationary satellite

(spinner). The unilluminated solar array area of the usual spinner (as sunlight falls on only one side) is illuminated by employing despun optical solar reflectors. The different mechanisms required for implementation of this arrangement are already space proven. The detailed study of this arrangement made by the authors reveals that the practical realization of this concept will enhance the power generating capability of the spinner and simultaneously reduce the weight (per unit power) and cost (per unit power) in such spinners.

(Author)

**A79-25375**\* The effect of maturation on the configuration of pristane in sediments and petroleum. R. L. Patience, S. J. Rowland, and J. R. Maxwell (Bristol, University, Bristol, England). *Geochimica et Cosmochimica Acta*, vol. 42, Dec. 1978, p. 1871-1875. 17 refs. Research supported by the Nuffield Foundation; Natural Environment Research Council Grant No. GR/3/2951; Grant No. NGL-05-003-003.

The absolute stereochemistry of pristane in a sample of contemporary marine zooplankton, Messel shale (Germany) and Djatibaram (Java) crude has been determined by gas chromatographic methods. The relative stereochemistry in Irati shale (Brazil), Green River (U.S.) crude, Halibut (Australia) crude has also been determined, and confirmed for a sample of the Green River shale. The stereoisomer distributions indicate a loss of stereospecificity of the phytol-derived 6(R), 10(S) pristane with increasing geological maturation. For example, the least mature geological sample, the Eocene Messel shale, contains solely the 6(R), 10(S) isomer, whereas a mature sample, Djatibaram crude, contains 50% of the 6(R), 10(S) isomer and 25% of each of the 6(R), 10(R) and 6(S), 10(S) isomers.

(Author)

**A79-25392** On the use of synoptic weather map typing to define solar radiation regimes. P. W. Suckling (Brandon University, Brandon, Manitoba, Canada) and J. E. Hay. *Monthly Weather Review*, vol. 106, Nov. 1978, p. 1521-1531. 16 refs. Research supported by the Department of the Environment and National Research Council of Canada.

A synoptic approach to the analysis of solar radiation regimes is undertaken with the aim of developing a synoptic solar radiation climatology. Synoptic weather types for an area including British Columbia and the adjacent regions of the northeastern Pacific are defined using an objective correlation classification technique. These weather types are shown to determine statistically distinct solar radiation distributions. However, further analysis shows that the distinctiveness of the solar radiation regimes is not sufficient to be used in practical applications such as interpolation between measurement stations, estimation of solar radiation inputs in the absence of observed data or in the explanation of the interannual variability of solar radiation. As a result, attempts to base a solar radiation climatology solely on the synoptic regimes defined using the readily available data and techniques employed in this study are not justified. However, the statistical analyses do suggest that the use of more appropriate synoptic data and typing techniques may overcome many of the inadequacies in the present study.

(Author)

**A79-25522** Selective covers for natural cooling devices. A. Addeo, E. Monza, M. Peraldo (Montedison S.p.A., Italy), B. Bartoli, B. Coluzzi, V. Silvestrini, and G. Troise (Napoli, Università, Naples, Italy). *Nuovo Cimento C, Serie 1*, vol. 1C, Sept.-Oct. 1978, p. 419-429.

Extraatmospheric space is practically a pure sink of radiation, and can be used as a nonconventional energy source. In previous papers we have shown that surfaces with an emissivity matched with the atmospheric 8-13-micron 'transparency window' (natural emitters) interact with cold space when exposed to clear sky at night, and undergo a sizable cooling effect. In this paper, starting from experimental results concerning the diurnal performances of natural emitters, the problem of their interaction with solar radiation is discussed, and the use of selective covers which shade the emitter from solar radiation, without preventing the interaction with cold space via emission of infra-red radiation is proposed.

(Author)

**A79-25548** Highly efficient quantum conversion at chlorophyll a-lecithin mixed monolayer coated electrodes. T. Miyasaka, T. Watanabe, A. Fujishima, and K. Honda (Tokyo University, Tokyo, Japan). *Nature*, vol. 277, Feb. 22, 1979, p. 638-640. 15 refs.

Miyasaka et al. (1978) have tried to combine different approaches to the design of solar conversion systems based on photosynthetic primary reactions by using a chlorophyll (Chl) a-coated SnO<sub>2</sub> transparent electrode as a photoanode. A maximum photocurrent quantum efficiency of 12-16% was attained with Chl a-stearic acid mixed monolayer systems. However, in this case a decrease of the quantum efficiency was observed at Chl a-stearic acid molar ratios of less than 1.0. A description is presented of an investigation in which these problems were overcome with the aid of an approach in which a phospholipid was used in place of fatty acid as a diluent for a Chl a monolayer. G.R.

**A79-25605 #** Energy for Europe from space. D. Kassing and K. K. Reinhartz (ESA, Spacecraft Power Supplies Div., Noordwijk, Netherlands). *ESA Journal*, vol. 2, no. 3, 1978, p. 179-187. 20 refs.

The European role in the development of the solar power satellite (SPS) concept is discussed. Numerous technical and economic studies have shown that, in principle, this concept can compete economically with other alternative advanced energy sources. The SPS has a major operational advantage over other solar energy conversion schemes in that it can deliver base-load electrical energy almost constantly with the exception of a small number of shadow periods (totalling less than one percent per year) and it can also economically supply areas which have little sunshine but a highly developed industry. B.J.

**A79-25720** An analytical expression for the specific output of wind turbine generators. J. Asmussen, G. L. Park (Michigan State University, East Lansing, Mich.), and D. Manner (Central Solar Energy Research Corp., Detroit, Mich.). *IEEE, Proceedings*, vol. 66, Oct. 1978, p. 1295, 1296; Comments, p. 1296, 1297, 1298; Reply, p. 1297, 1298. 5 refs. Research supported by the Central Solar Energy Research Corp.; Contract No. EG-77-5-52-4450.

Using a Rayleigh distribution for the wind speed frequency distribution, an analytical expression for wind turbine generator specific output is derived and expressed in terms of machine characteristics and mean wind speed. Results are expressed as a family of curves which are functions of the cut-in, rated, and cut-out wind speeds. The results are compared with numerical calculations using actual wind records and with the specific output curve of Harder (1977). (Author)

**A79-25744** High-efficiency thin-film polycrystalline silicon solar cells. T. L. Chu, S. S. Chu, C. L. Lin, and R. Abderrassoul (Southern Methodist University, Dallas, Tex.). *Journal of Applied Physics*, vol. 50, Feb. 1979, p. 919-921. 9 refs. Contract No. EY-76-C-03-1285.

The deposition of a silicon film containing a p-n junction on a metallurgical silicon substrate has been used for the preparation of thin-film silicon solar cells. The substrate was prepared by the unidirectional solidification of purified metallurgical silicon on a graphite plate, and the silicon film was deposited by the thermal reduction of trichlorosilane with hydrogen containing appropriate dopants. Solar cells of the p(+)/n/n(+)-metallurgical silicon/graphite configuration have been prepared, and the AM1 efficiencies of 9-10 sq cm area cells are up to 9.5%. (Author)

**A79-25745** Series resistance effects in /GaAl/As/GaAs concentrator solar cells. S. Charan, M. Konagai, and K. Takahashi (Tokyo Institute of Technology, Tokyo, Japan). *Journal of Applied Physics*, vol. 50, Feb. 1979, p. 963-968. 13 refs.

In the present paper, the series resistance of Zn-doped p-(GaAl)As/p-GaAs/n-GaAs solar cells prepared by liquid-phase epitaxy is calculated as a function of the sheet resistance of p-(GaAl)As and p-GaAs. The resistivity of such cells is found to be two times that of

Zn-diffused p-GaAs. The high resistivity of p-Ga0.3Al0.7As is attributed to the fact that the Zn acceptor level is deeper seated in Ga0.3Al0.7As than in p-GaAs. In the experimental portion of the study, it proved possible to reduce the series resistance by using fine grid patterns. V.P.

**A79-25746** Selective absorption of solar energy in ultrafine metal particles - Model calculations. C. G. Granqvist (Chalmers Tekniska Högskola, Göteborg, Sweden) and O. Hunderi (Norges Tekniske Högskole, Trondheim, Norway). *Journal of Applied Physics*, vol. 50, Feb. 1979, p. 1058-1065. 54 refs.

Spectral reflectance from metal surfaces with coatings of ultrafine metal particles dispersed in an insulating medium is computed. This model is appropriate to several kinds of selective absorbers for efficient photothermal conversion of solar energy. The main interest lies in the parameters which govern lambda (c), the wavelength below which the surfaces are good absorbers and above which they are good reflectors. The roles of coating thickness, substrate metal, particle shape and orientation, possible dielectric permeability (real and imaginary parts) of the embedding medium and of graded volume fractions of metal are analyzed. A particularly interesting result is that an enhanced eccentricity of the particles is, under most conditions, highly effective for shifting lambda (c) towards longer wavelengths. A similar shift is also found for spherical metallic shells surrounding dielectric cores of increasing size. (Author)

**A79-25748** The short-wavelength response of MIS solar cells. M. A. Green (New South Wales, University, Kensington, Australia). *Journal of Applied Physics*, vol. 50, Feb. 1979, p. 1116-1122. 15 refs. Research supported by the Australian Research Grants Committee, Utah Foundation, Electrical and Radio Research Board of Australia, and Sydney County Council.

With certain combinations of insulator thickness, surface-state density, and barrier height, it is shown that a dead layer can extend up to 750 Å into the semiconductor in MIS and Schottky solar cells. This can cause a fall off in short-wavelength response of the cell. Recombination at surface states can cause an additional fall off in spectral response at all wavelengths. By ensuring that the semiconductor surface is strongly inverted, these effects can be minimized and all carriers optically generated near the surface collected. This is confirmed by experimental measurements on Al/SiO(x)/p-Si MIS cells with particular attention focused on the 330-500-nm wavelength range. (Author)

**A79-25852 \* #** Space reflector technology and its system implications. K. W. Billman, W. P. Gilbreath (NASA, Ames Research Center, Moffett Field, Calif.), and S. W. Bowen (Beam Engineering, Inc., Sunnyvale, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 15th, Washington, D.C., Feb. 6-8, 1979, Paper 79-0545*. 18 p. 18 refs.

The technical feasibility of providing nearly continuous solar energy to a world-distributed set of conversion sites by means of a system of orbiting, large-area, low-area-density reflecting structures is examined. Requisite mirror area to provide a chosen, year-averaged site intensity is shown. A modeled reflector structure, with suitable planarity and ability to meet operational torques and loads, is discussed. Typical spatial and temporal insolation profiles are presented. These determine the sizing of components and the output electric power from a baselined photovoltaic conversion system. Technical and economic challenges which, if met, would allow the system to provide a large fraction of future world energy needs at costs competitive to circa-1995 fossil and nuclear sources are discussed. (Author)

**A79-25854 \* #** The solar power satellite concept - The past decade and the next decade. C. C. Kraft, Jr. (NASA, Johnson Space Center, Houston, Tex.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 15th, Washington, D.C., Feb. 6-8, 1979, Paper 79-0534*. 18 p. 24 refs.

## A79-25860

Results of studies on the solar power satellite concept, currently under evaluation by NASA and the Department of Energy, are summarized. The basic advantages provided by the concept are the near-continuous access to sunlight and the freedom from atmospheric effects and cloud cover. The systems definition studies have considered photovoltaic and thermal energy conversion systems and found both to be technically feasible, with the photovoltaic approach being currently preferred. A microwave test program is under way which will provide quantitative data on critical parameters, including beam forming and steering accuracy. Ballistic and winged launch vehicles have been defined for the transportation of construction materials, with the Shuttle expected to provide low-cost transportation to and from space. A reference system has been outlined for evaluating the concept in terms of environmental and other considerations. Preliminary estimates of natural resource requirements and energy payback intervals are encouraging. A.A.

**A79-25860 # A test bed for thermosyphon solar air collectors.** W. Lowry (Northern Arizona University, Flagstaff, Ariz.) and D. Pearson (L.S.W.B. Engineers, San Diego, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 15th, Washington, D.C., Feb. 6-8, 1979, Paper 79-0541.* 7 p. 8 refs.

A description of solar 'thermosyphon' air heating systems (those with no active circulating devices) is presented. Utilizing similar water system analyses, a model is developed to predict mass flow rates and mean system temperatures. Studies indicate the effects of various system geometries, glazing configurations, and frictional head losses. A test bed design is presented to provide experimental verification of these predictions. Consisting of two closed-loop air thermosyphon collectors, the bed will supply data for calculations of instantaneous efficiencies as a basis for comparing the effects of these parameter variations. (Author)

**A79-25871 \* # An approach to automated longwall mining.** E. R. Palowitch (U.S. Department of Energy, Pittsburgh Mining Technology Center, Pittsburgh, Pa.) and P. H. Broussard, Jr. (NASA, Marshall Space Flight Center, Huntsville, Ala.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 15th, Washington, D.C., Feb. 6-8, 1979, Paper 79-0532.* 9 p. 7 refs.

The longwall system of mining coal, providing advantages in the areas of productivity as well as health and safety, is described, and technological developments leading to a full automation of the system are discussed. In the longwall system large blocks of coal (up to 600 feet wide and up to 5000 feet long) are developed, with each block mined out by taking successive slices across the short dimension of the block and loading the broken coal onto a conveyor. A self-advancing system supports the roof over the length of the face throughout cutting and loading, with the supports advanced with the face, and the roof allowed to collapse behind them. A double-ranging drum longwall shearer provides the system with an efficient yaw, roll, and variable-thickness vertical control. Currently two machine operators function as error detectors and controllers. It is shown that electronic sensors can lead to a fully automated vertical control system, and automatic roll control is achievable with available instruments and machine tilt actuators. A.A.

**A79-25892 Environmental factors affecting the installation and operation of gas turbine engines in agricultural aircraft.** G. M. Hogg (Pratt and Whitney Aircraft of Canada, Ltd., Longueuil, Quebec, Canada). *Society of Automotive Engineers, Aerospace Meeting, San Diego, Calif., Nov. 27-30, 1978, Paper 781010.* 17 p. 6 refs.

The operational and economic environments associated with agricultural aircraft have dictated several changes to basic turbine engine installation procedures. As the ingestion of chemicals can cause rapid distress in the engine hot section, intake systems are proposed. Aircraft missions are analyzed, and the effect of high cycle time on major rotating components explained. In addition, with jet fuel seldom available at remote fields, alternates such as diesel and

gasoline - together with their limitations - are dealt with. Operational data is reviewed, recent studies and developments outlined, and the future of the gas turbine engine in agricultural aircraft discussed.

(Author)

**A79-25899 Effects of fuel properties on soot formation in turbine combustion.** D. W. Naegeli and C. A. Moses (U.S. Army, Fuels and Lubricants Research Laboratory, San Antonio, Tex.). *Society of Automotive Engineers, Aerospace Meeting, San Diego, Calif., Nov. 27-30, 1978, Paper 781026.* 11 p. 25 refs. Grant No. DAAG70-78-C-0001; Contract No. N00140-77-C-1345.

A combustor rig instrumented for measuring flame radiation, exhaust smoke, and gaseous emissions is used to study the sensitivity of combustor performance to the physical and chemical properties of fuels used in turbine combustion. These fuels include petroleum-base jet fuels, JP-5 syncrudes, water-fuel emulsions, and hybrid aromatic/methanol solutions. Examination of the effects of aromatic content, ring carbon content, and hydrogen-to-carbon (H/C) ratio on the flame radiation and exhaust smoke reveals that H/C ratio is the most effective indicator of soot formation. There is no observed effect of viscosity and end point on flame radiation and smoke. It is suggested that the mechanism for soot formation in the turbulent diffusion flame of a turbine combustor is due to gas-phase reactions and essentially independent of molecular structure. Water appears to play an important chemical role in soot reduction, probably as an additional source of hydrogen. S.D.

**A79-25900 Shale oil - The answer to the jet fuel availability question.** L. C. Angello, A. V. Churchill, C. L. Delaney, and H. R. Lander (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). *Society of Automotive Engineers, Aerospace Meeting, San Diego, Calif., Nov. 27-30, 1978, Paper 781027.* 11 p.

The Air Force began in 1974 a program to investigate the possibility of using alternative domestic liquid hydrocarbons, primarily shale oil, as sources for the standard jet fuel, JP-4, in order to ensure adequate fuel availability at an acceptable cost. The paper discusses the results of this program and its future goals. Results of processing studies on alternative hydrocarbon sources from shale oil are presented; it is found that shale oil processing resulted in specification turbine fuel when hydrotreated at 1500 psi, while coal liquids failed to meet specifications even when hydrotreated to 2200 psi. Fuel derived from shale oil was also found to be economically competitive under proper conditions. Results from shale oil-derived fuel combustion studies are presented, showing the effects of hydrogen and nitrogen content on combustor liner temperature, smoke and NO<sub>x</sub> emission. A projection of future specifications of Air Force aviation fuels is then presented. A.L.W.

**A79-25917 \* Evaluation of the application of some gas chromatographic methods for the determination of properties of synthetic fuels.** A. C. Antoine (NASA, Lewis Research Center, Cleveland, Ohio). *Society of Automotive Engineers, Aerospace Meeting, San Diego, Calif., Nov. 27-30, 1978, Paper 45 p. 6 refs.*

The purpose of the investigation was to evaluate the applicability, to some synthetic fuels, of some gas chromatographic methods now under development for use with petroleum based fuels. Thirty-two jet and diesel fuel samples which were prepared from oil shale and coal syncrudes were examined. The boiling range distribution of each was determined by gas chromatography, and from that data distillation properties were calculated. The calculated results gave sufficient agreement with the measured values that the equations could be useable in their present form. Bulk fuel properties were calculated for the 16 JP-5 and Diesel No. 2 type fuels. The results show that the equations would not give useable results. Capillary column gas chromatography was used to determine the n-alkane content of the eight JP-5 type samples and the results related to the observed freezing points. The results show that the concentrations of the long straight chain molecules in the fuels exert influence on the freezing point but are not the complete controlling factor. (Author)

A79-25926 International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Conference sponsored by NATO and International Solar Energy Society. Edited by F. A. Peuser (Kernforschungsanlage Jülich GmbH, Jülich, West Germany). Düsseldorf, West Germany, International Solar Energy Society, 1978. 373 p. (NATO/CCMS-85) \$15.90.

The papers report experience gained during the operation of various types of solar houses and pilot buildings using at least partial solar space heating and cooling and service water heating throughout the year. Topics studied include passive solar heating of buildings, a solar air heating and nocturnal cooling system, the Dornier/RWE solar house in Essen, the Mississauga solar house (Canada), the Thomson solar house (New Zealand), the Eindhoven solar house (The Netherlands), the zero energy house in Denmark, a passive solar heating system in Turkey, the Santa Clara Community Center Project, and a solar heated outdoor swimming pool. P.T.H.

A79-25927 What and where - Solar active systems or energy conservation in buildings. R. Bruno and H. Hörlster (Philips GmbH, Forschungslaboratorium, Aachen, West Germany). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 1-37.

This paper introduces a methodology which can be used to assist in choosing what to use where: solar active and/or energy conservation to reduce the use of conventional energy sources. It is shown that the particular set of choices made depends on location. Results are given for 'what and where' in this paper for four locations in Europe between latitudes 43 N to 58 N and three locations in the US from 35 N to 46 N. (Author)

A79-25928 Passive solar heating of buildings. J. D. Balcomb, J. C. Hedstrom, and R. D. McFarland (California University, Los Alamos, N. Mex.). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 39-57, 9 refs. ERDA-sponsored research.

Passive solar heating concepts - in which the thermal energy flow is by natural means - are described according to five general classifications: direct gain, thermal storage wall, solar greenhouses, roof ponds, and convective loops. Examples of each are discussed. Passive test rooms built at Los Alamos are described and results are presented. Mathematical simulation techniques based on thermal network analysis are given together with validation comparisons against test room data. Systems analysis results for 29 climates are presented showing that the concepts should have wide applicability for solar heating. (Author)

A79-25929 Prospects for solar heating and cooling in the United States. F. H. Morse (U.S. Department of Energy, Solar Heating and Cooling Research and Development Branch, Washington, D.C.). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 59-64.

The paper examines the prospects for solar heating and cooling in the U.S. by giving a summary of the solar heating and cooling program of the Federal Government and presenting the main results of a recent analysis of the economics of water and space heating. Objectives of the Government program are to (1) conduct research and development on reducing solar heating and cooling system costs and improve their performance, (2) collect, evaluate, and disseminate data on technical, environmental, and socioeconomic aspects of solar energy, and (3) demonstrate solar heating technology and cooling in new and existing buildings by 1979. It has been proved that solar heating is now economically competitive with electricity as is passive solar space heating. Extensive efforts to develop a sound market for

solar energy systems and products are being made. Economic criteria for feasibility of solar heating and cooling in residences have been developed. It was shown that enactment of a solar tax credit would have a dramatic positive effect on solar economic feasibility for detached residences. P.T.H.

A79-25930 The CCMS solar energy pilot study system performance reporting format. R. Allen (Maryland, University, College Park, Md.). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 65-78.

The paper gives an outline of the format recommended by the Committee on the Challenges of Modern Society for reporting the results of pilot studies of solar heating and cooling systems. The objective of the format is to assure that sufficient information is provided to enable the reader to make his own assessment of the performance of a solar heating and/or cooling system and to relate that performance, which was achieved in one particular climate and economic environment, to a different climate and economic environment. The reports should include environmental data, such as tables of monthly averages of (1) percent of sunshine or cloud cover fraction, (2) mean daily solar radiation on surface of specified orientation, and (3) ambient temperature. The system description should include building characteristics, collector characteristics, hot-side storage characteristics, cold-side characteristics, and cooling unit characteristics. The system thermal performance summary should include solar energy incident on collector plane, solar energy to hot-side storage, solar energy to space heating, heat recovery subsystem heat to space heating, solar energy to cooling, and percent of heating and service hot water provided by solar energy. Economic data should include labor, material, and total operating costs., P.T.H.

A79-25931 Solar heating, cooling and hot water production - A critical look at CCMS installations. R. Bruno (Philips GmbH, Forschungslaboratorium, Aachen, West Germany) and W. S. Duff (Colorado State University, Fort Collins, Colo.). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 79-94. 6 refs.

The paper discusses the reports on a year's performance of 17 representative experimental solar heating, cooling and/or hot water production installations located mostly in North America and Europe. System efficiencies were found to be a good measure of comparison for installations in different climates. Significant differences in system efficiencies, due primarily to differences in systems, are reflected by a special grouping of the load and insolation parameters. Results indicate that the presence of evacuated tubular collectors in a system translates into a substantial performance advantage over all other systems analyzed. A heat pump arrangement and an air system showed outstanding performance. P.T.H.

A79-25932 Solar air heating and nocturnal cooling system /CSU Solar House II/. S. Karaki (Colorado State University, Fort Collins, Colo.). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 95-129.

The heating system of the solar house is an air-heating system with an auxiliary gas duct furnace. The solar system consists of air heating collectors, pebble-bed storage, ducts of various sizes, a blower with constant speed motor, and automatic controls to collect, store and deliver solar heat to the building space. During the partial 1975-1976 heating season, the system provided 35,500 MJ of heat from the solar system which was 71% of the total load for the period recorded. Annual fractions are within the target design point of about 70% of the annual loads. The nocturnal cooling system had limited cooling capacity. Air leaks in the upper manifold of the

## A79-25933

collectors resulted in that the air flow through the collector was less than designed, so heat losses from the collector were greater than expected.

P.T.H.

**A79-25933 Dornier/RWE solar house in Essen, FRG.** K. Speidel (Dornier System GmbH, Friedrichshafen, West Germany) and J. Brosch (Rheinisch-Westfälisches Elektrizitätswerk, Essen, West Germany). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 131-139.

A year's data on the performance of a solar residential heating system in Essen, West Germany, are reported and discussed. The house was equipped with an active solar collector area of 65 sq m, seven storage tanks, a heat pump, and systems for control and measurement. The main operating modes of the system are (1) warming up the hot water storages, (2) warming up the storage tanks for heating, and (3) low temperature energy storage. The energy gained by the solar system was calculated to be 19,950 kWh in 1976 (52% of the energy needed). Monthly averages for total radiation on the collector field, auxiliary heating needed, electric energy for the heat pump, and total additional energy are given. The results indicate high efficiency of the system, although the cost is still excessive.

P.T.H.

**A79-25934 Experience with the MBB-solar testing house at Otterfing and relevant consequences on the commercial product.** H. K. H. Grallert (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings.

Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 141-160.

The paper reports experience with a solar heating system for a one-family prefabricated pre-alpine type house near Munich, West Germany. The collector area consists of double-glass flat plate collectors with 80 sq m effective area. Solar heat storage is provided by 8 cu m hot water storage tanks and soil storage compartments below the cellar floor. The design heat load per unit design temperature difference was 1.53 MWh/K-yr. Data presented include monthly energy distribution (heat demand for space heating and hot water supply, solar heat input to storage, and solar heat output), hot water storage temperature, actual and predicted monthly insolation, actual and predicted monthly energy demand, and actual and predicted monthly energy and oil savings for different operating modes. Despite unfavorable operating conditions during the first year of operation, the solar heating system saved 80% of the predicted annual oil demand.

P.T.H.

**A79-25935 Mississauga solar house /Mississauga, Ontario, Canada.** J. R. Sasaki (National Research Council, Ottawa, Canada). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings.

Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 161-172.

The paper reports on a project designed to demonstrate the technical feasibility of using a solar heating system with a water/air heat pump to provide a part of the space and service water heating requirements of a single-family home under Canadian climatic conditions. The solar collection system consists of 64.4 sq m of flat-plate water heating collectors surface mounted on the roof, and two concrete tanks containing a total of 18 cu m of water in the basement. A complete electric backup heating system was provided. The monthly average fraction of solar energy in the total energy supplied varied from 31% in January to 61% in June. For a one-year period the average fraction solar was 42% of the total space and service water heating requirement. The total solar energy used in November and December exceeded the solar energy collected in the same period, which demonstrates the seasonal carry-over feature of the heat storage unit.

P.T.H.

**A79-25936 Thomson Solar House I.** S. W. Thomson (Dimond Industries, Ltd., Wellington, New Zealand). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 173-186. 9 refs.

A solar house built near Wellington, New Zealand, where the average home must be heated 50% of the year, is described. A 37 sq m glass roof is designed over an internal courtyard room, where the internal glass walls act as the second glass cover on a solar collector and the floor acts as the heat sink. The active part of the system consists of a 33 sq m vertical flat plate collector. Water is the heat transfer medium, effecting a straight exchange to copper floor coils. The system provides 50% of heating requirements. Low temperature collection proved the more efficient. Annealed copper tube circuits have had no maintenance problem over ten years.

P.T.H.

**A79-25937 Solar houses in Blagnac /Blagnac, Haute-Garonne, France.** J. P. Marie (Sécrétariat Permanent du Plan-Construction, Paris, France) and B. Bourret (Institut National des Sciences Appliquées, Toulouse, France). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings.

Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 187-200.

The paper reports on the relative performances of eight solar houses near Toulouse, France: five dwellings of 277 cu m, equipped with a large solar collector of 30 sq m area, where space heating and service hot water are provided by solar and gas energy; and three dwellings of 257 cu m, equipped with 3.5 sq m collectors for service hot water, the house being heated with gas. For the space-heating experiment, the collectors were inclined 15 deg, and the heat distribution was by means of air. In the service hot water systems, water is pumped onto the top of the collectors, from where it flows down. Over a six-month period from December to May a global gain of 26 percent for all systems was noted. The percent of heating provided by solar energy ranged from 12 percent in December to 45 percent in April.

P.T.H.

**A79-25938 The performance of the heating system in the solar house of the Eindhoven University of Technology.** C. W. J. van Koppen and J. P. S. Thomas (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings.

Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 201-215.

The integrated solar house at Eindhoven, The Netherlands, has a solar roof tilted at an angle of 48 deg consisting of 51 sq m of aluminum finned tube absorber plates coated with black chrome. In the 4.1 cu m solar heat storage tank the advantages of thermal stratification are exploited to the limits of their potential. For example, the return flow from the collectors enters the storage via a floating inlet, a thin-walled flexible hose that automatically moves to the level in the tank where the temperature is equal to the collector exit temperature. Fresh intake air for the ventilation of the house passes along the bottom of the tank, thereby cooling the water there and itself being preheated. Over a one-year period a total of 12,492 kWh of solar heat was used, as compared with the 30,447 kWh of net heat for heating and hot water required. A fuel savings of 1900 cu m of natural gas is calculated.

P.T.H.

**A79-25939 Performance of residential solar heating and cooling system with flat-plate and evacuated tubular collectors - CSU Solar House I.** W. S. Duff, T. M. Conway, G. O. G. Löf, D. B. Meredith, and R. B. Pratt (Colorado State University, Fort Collins, Colo.). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings.

Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 217-230. Research supported by the U.S. Department of Energy.

Solar House I measurements have provided comparison data on space heating, water heating, and cooling by systems in which flat-plate collectors and evacuated tube collectors were used. A system comprising an evacuated tubular collector, lithium bromide absorption water chiller, and associated equipment was found to be highly effective in providing space heating and cooling to a small building. This system was able to supply twice the space heating and several times the cooling obtainable from an equal occupied area of good quality flat-plate collectors. A greater fraction of the domestic hot water can be obtained by supplying its heat from main storage.

P.T.H.

**A79-25940 CCMS solar energy pilot study reporting format - The zero energy house in Denmark.** T. V. Esbensen and V. Korsgaard (Danmarks Tekniske Højskole, Lyngby, Denmark). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 231-248.

The paper deals with the design of an experimental single-family solar house consisting of two dwelling units of 60 sq m each and a 70 sq m atrium. The feasibility of utilizing a solar heating system with seasonal heat storage for heating and hot water supply is demonstrated for climatic conditions typical of Denmark. V.P.

**A79-25941 The Philips experimental house - A system's performance study.** R. Bruno, W. Hermann, H. Hörl, R. Kersten, K. Klinkenberg (Philips GmbH, Forschungslaboratorium, Aachen, West Germany). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 249-263.

The present paper deals with a theoretical and experimental study of means of energy conservation with emphasis on solar energy utilization. An experimental house constructed on the basis of this study incorporates such features as thorough thermal insulation of walls and windows, controlled air ventilation, heat recovery from exhaust air and waste water, utilization of heat pumps in various modes of operation, and utilization of solar energy by means of evacuated selective solar collectors. V.P.

**A79-25942 Passive solar heating system in Turkey.** A. G. Mutdogan (Ministry of Energy and Natural Resources, Dept. of Energy, Ankara, Turkey). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings.

Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 265-280.

The paper deals with a four-year solar heating program initiated in June 1977 to develop solar houses appropriate for the climatic conditions prevailing in Turkey. The design and characteristics of four solar house versions are discussed. These are houses with solar heating but without electricity and running water; houses with solar heating and electricity but without running water; houses with solar heating and cooling, running water, and electricity; and apartment buildings with solar heating and cooling. V.P.

**A79-25943 Passive solar house in Vetlanda - Interim report.** E. Ofverholm (Kungl. Tekniska Högskolan, Stockholm, Sweden). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings.

Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 281-289.

The thermal performance of a passive solar heating system in a house in Vetlanda, Sweden is reported. Heating is provided by south windows and stored by a concrete slab foundation. Excessive interior temperatures are avoided by means of room thermostats, a variable air flow ventilation system and fixed solar screening. Heat losses are

reduced by thermal insulation (190mm in the walls and 300mm in the roof) and insulating four-pane windows. The solar energy collected from October 1976 to April 1977 was calculated from values measured by pyranometers behind the windows and from the difference between heat loss and auxiliary energy consumed. It is concluded that the solar contribution to space heating has been poor, due to less insolation than normal, excessive window shading, the inability of the system to collect all available solar energy on clear days and lower than normal ambient temperatures. A computer simulation may help to solve problems of optimal window shading and thermal measurements are being continued. A.L.W.

**A79-25944 Solar heating and cooling performance of the Los Alamos National Security and Resources Study Center.** H. S. Murray, J. C. Hedstrom, and J. D. Balcomb (California, University, Los Alamos, N. Mex.). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 291-316. Research sponsored by the U.S. Department of Energy.

The solar heating, cooling and ventilation systems of the National Security and Resources Study Center at the Los Alamos Scientific Laboratory are discussed. The building, designed to conserve energy is heavily insulated. The heating, ventilation and air conditioning system, which makes use of air recirculation, heat recovery and complete shutdown at night, is a two-zone (perimeter and interior) variable air volume system with separate supply fans and cooling coils for each zone. The energy system consists of a single, roof-mounted solar collector array and heat exchanger, two storage tanks, and two water chillers - a lithium bromide absorption chiller and a Rankine cycle unit. Monthly and daily summaries of the system's thermal performance are presented for the heating season of November 1977 to April 1978, along with monthly summaries for the August through September 1977 cooling season. The solar energy contribution to heating or cooling ranged from 63% in January to 99% in April. Thermal performance characteristics of the solar collector, heat transfer, heat storage and air conditioning subsystems are also presented. A.L.W.

**A79-25945 Santa Clara Community Center Project, USA.** M. Hemsch, S. Ayraud, and W. Niemeyer (Santa Clara, University, Santa Clara, Calif.). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 317-330.

The paper presents the results of a year's operation of the solar space heating and cooling and service water heating system of the Santa Clara Center, a facility with 2500 sq cm net interior area. The solar system was sized to meet a peak heating load of 3060 MJ/day and a peak cooling load of 6220 MJ/day. The priority for use of the solar energy is first to drive the chillers and then to provide heating energy to the building or hot storage. The collectors are double glazed with selectively coated flat roll bond copper absorber plates. Monthly and annual values of the mean daily heat flows are presented. The percent solar contribution to the energy requirements of the building ranged from 24.5% in December to 78.9% in May. The total gas energy saved over one year was 122.3 billion J, while the system required a total of 19.9 billion J of electric energy more than the equivalent nonsolar system. P.T.H.

**A79-26038 Oxidation of SO<sub>2</sub> on the surface of fly ash particles under low relative humidity conditions.** Y. Mamane (NOAA, Atmospheric Physics and Chemistry Laboratory, Boulder, Colo.; Technion - Israel Institute of Technology, Haifa, Israel) and R. F. Pueschel (NOAA, Atmospheric Physics and Chemistry Laboratory, Boulder, Colo.). *Geophysical Research Letters*, vol. 6, Feb. 1979, p. 109-112. 9 refs. Research supported by the U.S. Environmental Protection Agency.

## A79-26131

**A79-26131 \*** # **Photovoltaic power systems for rural areas of developing countries.** L. Rosenblum, W. J. Bifano, G. F. Hein, and A. F. Ratajczak (NASA, Lewis Research Center, Cleveland, Ohio). *United Nations, International Seminar on Solar Energy, Tokyo, Japan, Feb. 5-10, 1979, Paper 18 p. 9 refs.*

Photovoltaic (PV) applications for rural areas of underdeveloped countries are discussed in relation to PV system technology, reliability, and present and projected cost. The information presented is derived mainly from NASA, Lewis Research Center experience with PV systems deployed with a variety of users for applications relevant to LDCs. A detailed description of two village power systems is included. Energy cost comparisons are presented for PV systems versus alternative energy sources. It is concluded, based on present PV system technology, reliability and cost that photovoltaics provides a realistic energy option for LDCs in both the near- and far-term. (Author)

**A79-26163** **On the diffusive instability of some simple steady magnetohydrodynamic flows.** P. H. Roberts (Newcastle-upon-Tyne, University, Newcastle-upon-Tyne, England) and D. E. Loper (Florida State University, Tallahassee, Fla.). *Journal of Fluid Mechanics*, vol. 90, Feb. 27, 1979, p. 641-668. 30 refs. NSF Grant No. EAR-74-22249.

The paper investigates the stability characteristics of some simple steady magnetohydrodynamic flows within an axisymmetric container of arbitrary electrical conductivity, giving attention in particular to rapidly rotating fluids and a geomagnetohydrodynamic basic state representing a rigidly rotating homogeneous fluid with a uniform axial electric current. The stability of a fluid of finite electrical conductivity in a perfectly conducting axisymmetric container was analyzed, and a consistency condition was obtained, relating the change in frequency of a dissipationless eigenmode due to fluid resistivity to integrals of that eigenmode, and it was found that a class of modes (exceptional modes) exists which are destabilized by the introduction of Ohmic dissipation. This analysis was generalized to include finite conductivity of the walls. The effect of density gradients on the unstable modes was then investigated, and it was found that all fast modes and ordinary slow modes have standard stability properties in response to density gradients, but exceptional slow modes are stabilized by a top-heavy gradient and destabilized by a bottom-heavy gradient. P.T.H.

**A79-26176** **Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978.** Meeting sponsored by the American Society of Mechanical Engineers. Edited by C. H. Marston (General Electric Co., Philadelphia, Pa.). New York, American Society of Mechanical Engineers, 1978. 250 p. Members, \$15.; nonmembers, \$30.

The papers presented deal with the fluid dynamical aspects of the design of advanced energy systems such as wind energy, MHD energy, wave system, and ocean thermal energy conversion. Topics discussed include a two-dimensional vortex sheet model of a Savonius rotor, control of wind power distribution in vortex augmentors, diffuser designs for improved wind energy conversion, the disk MHD generator, supersonic and subsonic diffusers for MHD applications, a high efficiency wave engine, modeling two phase flow in a swirl combustor, and working fluids and turbines for OTEC power systems. P.T.H.

**A79-26177** # **The interaction of the wind field with a horizontal axis wind turbine.** R. H. Kirchhoff, K. Modarresi, and P. Murphy (Massachusetts, University, Amherst, Mass.). In: *Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978.* New York, American Society of Mechanical Engineers, 1978, p. 1-13. 12 refs. U.S. Department of Energy Contract No. PF-67025-F.

A steady state, axisymmetric, potential flow model of the wind field upstream of a horizontal axis wind turbine is presented. The blade disk is modeled by a distribution of sources in its plane of rotation. An analytical expression for the potential function is developed. Sample flow field calculations for the UMass Solar Habitat I 25 kW wind turbine are presented. The dynamic interaction between the horizontal gustiness of the wind field and the instantaneous power generated by this 25 kW wind turbine is investigated by measuring the transfer function between wind speed and the generator voltage. (Author)

**A79-26178** # **A two dimensional vortex sheet model of a Savonius Rotor.** E. S. Van Dusen and R. H. Kirchhoff (Massachusetts, University, Amherst, Mass.). In: *Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978.* New York, American Society of Mechanical Engineers, 1978, p. 15-31. 15 refs.

A two-dimensional inviscid flow model is developed for a vertical axis windmill of the Savonius Rotor type with two foils of arbitrary shape. The solution is constructed by the superposition of streamfunctions for the uniform flows and the vortex sheets representing the foils and the wake vorticity. Calculations are performed in the reference frame of the rotating foils and include a time developing wake as vorticity is shed from the trailing edge of each foil. The results from different time steps, hence rotor orientations, are presented as plots of torque, streamlines, and power coefficient over a wide range of tip speed ratios. Results investigating the time step between solutions and different geometries are also presented and compared to empirical values. A heuristic stall model to account for flow separation is included in a manner that anticipates future viscous analysis. (Author)

**A79-26179** # **Vortex sheet analysis of the Giromill.** R. E. Wilson (Oregon State University, Corvallis, Ore.). In: *Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978.* New York, American Society of Mechanical Engineers, 1978, p. 33-43. 12 refs. Contract No. EY-76-S-06-2227. ERDA Task 23.

A two-dimensional analysis of the performance and flowfield of the Giromill is presented. The Giromill is a vertical-axis wind turbine with straight blades that are articulated to produce maximum energy extraction from the wind. It is found that the power coefficient and windwise force coefficient for the Giromill have the same limit as obtained for the horizontal-axis wind turbine. A cross-wind force is also obtained with this type of wind turbine. The cross-wind force is of second order and decreases with tip speed. Streamlines and velocity profiles are illustrated for several loading conditions. (Author)

**A79-26180** # **Wind power distribution, control, and conversion in vortex augmentors.** P. M. Sforza and W. Stasi (New York, Polytechnic Institute, Farmingdale, N.Y.). In: *Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978.* New York, American Society of Mechanical Engineers, 1978, p. 45-57. 7 refs. Contract No. E(49-18)-2358.

The Vortex Augmentor Concept (VAC) for fluid power conversion employs several basic aspects of fluid engineering: fluid power, fluid power control, and fluid machinery for power conversion. These features and their influence on design and development of an advanced wind energy conversion machine are discussed. The key concept is the generation and control of discrete vortical flows of high power density by appropriate interaction of aerodynamic surfaces with natural winds of relatively low power density, and then the use of suitably designed turbines to extract energy from the compacted vortical field. Generation of a power field in space is accomplished by the interaction of the fluid stream with an augmentor surface. Control of power level and distribution is

affected by configurational changes of the augmentor surface. Tests on various augmentor concepts are reported. P.T.H.

**A79-26181 # Some flow analyses for Tornado-type wind turbines.** C. T. Hsu (Iowa State University of Science and Technology, Ames, Iowa), G. L. Mellor (Princeton University, Princeton, N.J.), and J. T. Yen (Grumman Aerospace Corp., Research Dept., Bethpage, N.Y.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 59-71. 6 refs. Research supported by the Iowa State University of Science and Technology, U.S. Department of Energy, and New York State Energy Research and Development Authority.

The power coefficient of a Tornado-type wind turbine is analyzed for an incompressible and inviscid fluid with the assumption of radially equilibrium flow. A power coefficient based on the tower base area was chosen first. It is found that this coefficient mainly depends on the axial velocity allowed to be produced at the turbine outlet. A power coefficient based on the tower frontal area is computed next. It is found that our result is much more physically meaningful than that of Loth. Also, it is found that for the optimum value of the turbine outlet velocity, the ratio of the maximum power output of a Tornado-type wind turbine to the conventional wind turbine of the same size is proportional to the cube of the ratio of the tower to the turbine diameter. (Author)

**A79-26182 # Diffuser designs for improved wind energy conversion.** K. M. Foreman and B. L. Gilbert (Grumman Aerospace Corp., Bethpage, N.Y.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 73-91. 13 refs. Contract No. EY-76-C-2-2616.

The paper describes experimental work on two classes of compact diffusers for augmenting the power output of wind energy conversion systems. The first employs slot-injected air to energize the boundary layer of the internal flow, while the second employs short ring airfoils. The low pressure distribution along the internal ring surface of high-lift airfoil shapes induces augmented flow through the turbine if the latter is placed in a proper axial position. Results on baseline models and variants are presented in terms of an overall augmentation ratio and a dynamic pressure ratio. A baseline diffuser configuration combined with a nonoptimized turbine was shown to be able to produce almost 3.5 times the ideal power coefficient of a conventional wind turbine of same size. P.T.H.

**A79-26183 # Two-dimensional MHD channel design.** E. Doss, H. Geyer, Z. El-Derini, and R. K. Ahluwalia (Argonne National Laboratory, Argonne, Ill.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 93-109. 18 refs. Contract No. W-31-109-eng-38.

A two-dimensional MHD channel design model was developed for three modes of operation: the velocity, Mach number, and pressure modes. The MHD channel geometry can be predicted, given the distribution of any of these three parameters and the channel aspect ratio. The results for these modes are in excellent agreement with the results obtained with an original design where the area is specified. An arcing model is incorporated in the analysis, which allows MHD channels with cold walls to be rationally analyzed. Calculations indicate doubling of boundary layer voltage drop and 30% increase in wall heat flux as the wall temperature is reduced to 800 K from 1600 K; the two adverse effects combine to reduce channel output by 30%. A one-dimensional slag flow model is coupled to the two-dimensional flow model. The presence of the slag layer is shown to elevate the apparent wall temperature and thus improve channel performance, especially at lower wall temperatures. P.T.H.

**A79-26184 # Velocity, temperature, and electrical conductivity profiles in hydrogen-oxygen MHD duct flows.** M. S. Greywall (Wichita State University, Wichita, Kan.) and C. C. Pian (NASA, Lewis Research Center, Cleveland, Ohio). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 111-120. 8 refs. Contract No. EF-77-A-01-2647; Grant No. NSG-3186.

This paper presents results of two-dimensional duct flow computations for radial distributions of velocity, temperature, and electrical conductivity. Calculations were carried out for the flow conditions representative of NASA Lewis hydrogen-oxygen combustion driven MHD duct. Results are presented for two sets of computations: (1) profiles of developing flow in a smooth duct, and (2) profiles of fully developed pipe flow with a specified streamwise shear stress distribution. The predicted temperature and electrical conductivity profiles for the developing flows compared well with available experimental data. (Author)

**A79-26185 # Subsonic diffusers for MHD generators.** T. R. Brogan (Meppco, Inc., Boston, Mass.), J. J. Idzorek (FluiDyne Engineering Corp., Minneapolis, Minn.), and D. Swallom (Maxwell Laboratories, Inc., Woburn, Mass.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978.

New York, American Society of Mechanical Engineers, 1978, p. 125-138. 10 refs. Research supported by the U.S. Department of Energy.

The paper discusses the interaction between the diffuser and MHD channel performance and reviews the state of the art regarding short subsonic diffusers with high inlet blockage. It has been found that conventional short, straight-wall, three-dimensional nonseparating diffusers will display a recovery coefficient of 0.45-0.50 in the MHD environment. This performance leaves much to be desired. With high inlet blockage, the performance of a nonseparating diffuser is comparable to that of a configuration operating with incipient separation. The diffuser exit flow pattern may cause a strong recirculation pattern to develop in the steam generator. This factor should be taken into account in the design of the radiant boiler. Vortex generators, contouring, and gas injection are potential methods for improving MHD diffuser performance, but any design must offer the compatibility of the diffuser configuration with the high velocity slag and seed-laden gas. P.T.H.

**A79-26186 # On supersonic and subsonic diffusers for magnetohydrodynamic generator applications.** G. D. Roy (Tennessee State University, Nashville, Tenn.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 139-152. 14 refs. Contract No. EX-76-C-01-1760.

Experimental investigations were made of both supersonic and subsonic diffusers with coal combustion gas (for MHD generator applications) with high entrance boundary layer blockage factors in the subsonic diffuser. It was found that a constant-area supersonic diffuser performed adequately. The pressure recovery is approximately 0.6 of the normal shock recovery with a diffuser length of approximately 70 percent of generator channel length. The subsonic diffusers have a maximum pressure recovery coefficient of 0.76 with an inlet blockage factor (B) of 0.16, which decreases to 0.6 at a higher blockage factor of 0.20, with 6 deg half angle. A quasi-one-dimensional analysis with friction, heat transfer and chemical reaction predicts well the pressure and heat-flux distribution in the channel, supersonic diffuser, and subsonic diffuser with small divergence angles. At large divergence angles, experimentally determined correction factors are applied. (Author)

**A79-26187 # High efficiency wave engine.** H. E. Weber (Pennsylvania State University, Radnor, Pa.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual

## A79-26188

Meeting, San Francisco, Calif., December 10-15, 1978.  
New York, American Society of Mechanical Engineers,  
1978, p. 153-166. 10 refs.

A calculation method for determining the performance of a wave engine is outlined. It is applied to a wave engine with nozzles at the exit of the rotor blades and multiple reentries in the expansion portion of the cycle. Relatively high compression and expansion efficiencies are obtained after inclusion of the major losses in such a machine. Since each rotor blade passes through both hot and cold gas in each revolution, blade temperatures remain low for relatively high gas or combustion temperatures. This situation permits attainment of high cycle efficiencies. (Author)

**A79-26188 # Flow modeling of an atmospheric pressure, entrained-type coal gasifier.** J. D. Bianca, W. P. Pauver (Combustion Engineering, Inc., Windsor, Conn.), and J. G. McGowan (Massachusetts, University, Amherst, Mass.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 167-181. 14 refs.

This paper presents the results of a fluid mechanical study of an atmospheric pressure, entrained-type coal gasifier. A discussion of the criteria used for the flow modeling is given, resulting in the identification of the key gasifier design parameters that influence overall gasifier aerodynamics. The experimental flow modeling work, using both velocity and concentration measurements, is summarized and results are presented which led to modification of the original gasifier design. (Author)

**A79-26189 # Modeling two-phase flow in a swirl combustor.** A. K. Varma, W. S. Lewellen, and H. Segur (Aeronautical Research Associates of Princeton, Inc., Princeton, N.J.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 183-197. 11 refs.

A phenomenological model of flow in a cyclone coal combustor-gasifier has been developed. The principal purpose of the model was to provide guidance for the design and scaling of high pressure cyclone combustors. The model predicts how four performance parameters - carbon conversion efficiency, ash separation, pressure drop and heat transfer - depend on basic geometrical design variables and flow parameters of the system. Comparison of model predictions with some limited experimental measurements show reasonable agreement but further testing is necessary to determine the empirical parameters. Model derivation and sensitivity analysis identify the phenomena which have critical effects on the combustor performance. (Author)

**A79-26190 # Modeling the champagne effect in compressed air energy storage.** E. B. Smith, W. A. Blecher, and A. J. Giramonti (United Technologies Research Center, East Hartford, Conn.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 199-212. 11 refs.

Analyses were performed to determine the effectiveness of several modifications in the design of the hydraulic compensation system of a compressed air energy storage system in eliminating the possibility of blow out of the storage cavern. One alternative is to include a U-bend trap, and a previous analysis focused on determining the minimum depth of the U-bend needed to prevent blowout. This analysis is extended to determine the effect of flaring the shaft. A steady-state analysis of the full two-phase flow equations in the vertical shaft yields the pressure, velocity, and average density of the water-air mixture in the vertical shaft. Balancing the kinetic and potential energy then gives the added U-bend depth necessary to absorb the column inertia. Another analysis was performed to determine if oversizing the cavern could prevent cavern blowout. It

was found that blowout could be prevented by a U-bend with depth about 10% of the cavern depth. Use of a flared shaft does not significantly reduce the required depth. Oversizing the cavern by about 10% will also work. P.T.H.

**A79-26191 # Performance of a hydraulic air compressor for use in Compressed Air Energy Storage power systems.** J. A. Berghmans (Leuven, Katholieke Universiteit, Leuven, Heverlee, Belgium) and F. W. Ahrens (Argonne National Laboratory, Argonne, Ill.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 213-227. 7 refs. Research supported by the U.S. Department of Energy.

A fluid mechanical analysis of a hydraulic air compression system for Compressed Air Energy Storage (CAES) application is presented. With this compression concept, air is charged into an underground reservoir, for later use in power generation, by entraining bubbles into a downward flow of water from a surface reservoir. Upon releasing the air in the underground reservoir, the water is pumped back to the surface. The analytical model delineated in the paper is used to predict the hydraulic compressor performance characteristics (pumping power, pump head, compression efficiency) as a function of water flow rate and system geometrical parameters. The results indicate that, although large water pumps are needed, efficiencies as high as 90% (relative to ideal isothermal compression) can be expected. This should result in lower compression power than for conventional compressor systems, while eliminating the need for the usual intercoolers and aftercooler. (Author)

**A79-26192 # Working fluids and turbines for OTEC power systems.** D. D. Rosard (Westinghouse Electric Corp., Steam Turbine Div., Lester, Pa.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 229-246. 10 refs.

The paper discusses the thermodynamic and mechanical relations which affect the performance and size limitations of designs for the turbine of open-cycle ocean thermal energy conversion. Two key design parameters influencing turbine efficiency are the velocity ratio and the average gauging ratio (ratio of total flow area at throat of blades to total annulus area). It is shown that the optimum velocity ratio varies only slightly with gauging, and that higher values of gauging lead to lower efficiency as a result of higher axial exit velocity. The blade bending stresses are also taken into account in evaluating limiting performance. Parameters of an illustrative turbine design using the largest available disk (17 ft in diameter) are given. The combination of speed, diameter, and blade length are well within the limits of acceptable centrifugal stresses for a variety of blade materials including steel, titanium, aluminum, or fiberglass. P.T.H.

**A79-26201 Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978.** Meeting sponsored by the American Society of Mechanical Engineers. Edited by F. Kreith, R. Boehm (Utah, University, Salt Lake City, Utah), J. Mitchell (Wisconsin, University, Madison, Wis.), and R. Bannerot (Houston, University, Houston, Tex.). New York, American Society of Mechanical Engineers, 1978. 83 p. Members, \$5.00; nonmembers, \$10.00.

Papers are presented on air heating unglazed flat plate solar collectors, natural convection in inclined two-dimensional compound parabolic concentrators, and analysis of energy storage by phase change with an array of cylindrical tubes. Consideration is also given to earth-conducted heat losses from thermal storage systems, and to heat transfer and calorimetric studies of a direct contact-latent heat storage system. B.J.

**A79-26202 # Analysis and design of air heating unglazed flat plate solar collectors.** J. M. Alcone, A. B. Donaldson, and W. P.

Schimmel, Jr. (Sandia Laboratories, Albuquerque, N. Mex.). In: Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 1-6. 13 refs. Contract No. AT(29-1)-789.

A simplified analysis of unglazed flat plate air heating collectors is developed for use in conjunction with studies of systems involving these collectors. To develop the analysis, an energy balance is formulated for a generalized unglazed collector configuration and then solved via the Laplace transform technique. The analysis was verified by application to a collector configuration for which experimental results are available. Based on the verified analysis, preliminary design and optimization procedures are developed and illustrated by example. A discussion of the relative importance and interplay of the various parameters used to describe collector performance is developed via sensitivity analysis to aid in understanding the behavior of unglazed collectors. (Author)

**A79-26204 # Heat transfer in a solar radiation absorbing fluid layer flowing over a substrate.** Y. Kurosaki and R. Viskanta (Purdue University, West Lafayette, Ind.). In: Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978.

New York, American Society of Mechanical Engineers, 1978, p. 13-21. 16 refs.

A simple theoretical model has been developed to predict the temperature distribution in an irradiated liquid or liquid suspension flowing along an opaque substrate. The fluid is irradiated by focusing solar radiation on the layer. In the analysis the absorption and emission of radiation by the fluid and emission and reflection by the substrate are considered. A two-band (semitransparent and opaque) radiation model is employed to assess the feasibility of absorbing solar radiation directly in fluid and using the fluid layer-substrate system as a solar collector. The results obtained show that for given flow and thermal conditions there is an opacity of the fluid which yields an optimum thermal performance (e.g. collection efficiency) of such a system. The results also show that, all conditions and parameters being the same, a fluid in laminar flow will yield better performance than a fluid in turbulent flow. (Author)

**A79-26206 # Natural convection heat transfer in small and moderate aspect ratio enclosures - An application to flat plate collectors.** B. A. Meyer, M. M. El-Wakil, and J. W. Mitchell (Wisconsin University, Madison, Wis.). In: Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978.

New York, American Society of Mechanical Engineers, 1978, p. 29-33. 16 refs. Contract No. E(11-1)-2941.

**A79-26207 # Analysis of energy storage by phase change with an array of cylindrical tubes.** N. Shamsundar (Houston University, Houston, Tex.) and R. Srinivasan. In: Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978.

New York, American Society of Mechanical Engineers, 1978, p. 35-40. 11 refs. Contract No. EG-77-C-04-3974.

An analysis of two-dimensional phase change of a salt or other phase change material (PCM) is made for the tube array in a shell and tube heat exchanger. The tubes are cooled convectively inside by a flowing fluid. The variation of total heat flux with time is calculated for several combinations of design parameters, for in-line as well as staggered tube arrangements. This information is very useful in designing PCM heat exchangers for solar and other energy storage units. The results indicate that the one-dimensional formulae that are currently in use for design have large errors, and are unable to fully account for the effect of tube arrangements. The influence of

superheat in the liquid-is studied, and a simplified method for ascertaining this influence is presented. (Author)

**A79-26208 # Earth-conducted heat losses from thermal storage systems** L. U. Lilleleht, J. T. Beard (Virginia University, Charlottesville, Va.), and L. M. Fafarman. In: Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 41-44. 7 refs. Contract No. E(40-1)-5136.

In an effort to reduce the storage costs of solar thermal energy, it has been proposed to use the ground to provide some or all of the insulation of the storage medium and some of the thermal capacity as well. Analyses of heat losses from such systems are often quite difficult, especially for the more complicated geometries and due to their cyclical nature of operation. This paper presents a new method of estimating the steady-state heat conduction losses from storage systems in the shape of segments of spheres. The use of orthogonal toroidal coordinates is illustrated for predicting these losses from constant temperature objects imbedded in earth with another constant surface temperature. (Author)

**A79-26209 # Sulfuric acid-water - Chemical heat pump/energy storage system demonstration.** E. C. Clark (Rocket Research Co., Redmond, Wash.) and C. C. Hiller (Sandia Laboratories, Albuquerque, N. Mex.). In: Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 45-50. 5 refs. Research supported by the U.S. Department of Energy.

**A79-26210 # Heat transfer and calorimetric studies of a direct contact-latent heat energy storage system.** V. A. Costello, S. S. Melsheimer, and D. D. Edie (Clemson University, Clémson, S.C.). In: Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 51-60. 21 refs. Contract No. E(40-1)-5190.

A possible solar energy storage process is to store energy in the latent heat of fusion of salt hydrates with high heats of fusion and favorable melting points. The present study investigated the feasibility of a latent storage system with direct contact heat transfer. Three salt systems (calcium chloride, disodium hydrogen phosphate, and sodium sulfate) were studied as well as direct contact sensible heat storage in water. Volumetric heat transfer coefficients and thermal storage efficiencies were determined at various flow rates and column heights, and with varying numbers of diffusers. Good heat transfer rates and thermal storage efficiencies were obtained in the direct contact storage device. B.J.

**A79-26242 A better approach to the evaluation of the series resistance of solar cells.** K. Rajkanan (McMaster University, Hamilton, Ontario, Canada) and J. Shewchun (Brown University, Providence, R.I.). *Solid-State Electronics*, vol. 22, Feb. 1979, p. 193-197. 23 refs. Research supported by the National Research Council of Canada; Contract No. E(04-3)-1203.

Series resistance is an important parameter in solar cell design and fabrication. Methods reported in literature for its determination are not suitable for routine use. This paper describes a simple method for obtaining the series resistance. Universal current-voltage characteristics of the solar cells are also given to illustrate the effects of series and shunt resistance. An explanation is offered for the often observed drop in efficiency when small area cells are scaled upward. Cells less than 0.25 sq cm represent the intrinsic potential of any given structure or diode but do not reflect series resistance effects that must be eliminated with larger area cells and the practical problems of gridding to allow for current collection. (Author)

**A79-26243 Diffusion length measurements in Schottky barrier GaAs solar cells.** R. J. Lender, S. Tiwari, J. M. Borrego, and S. K. Ghandhi (Rensselaer Polytechnic Institute, Troy, N.Y.). *Solid-*

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*State Electronics*, vol. 22, Feb. 1979, p. 213, 214. 7 refs. Contract No. EG-77-S-01-4116.

**A79-26353 # Radiation regime of inclined surfaces (Radiatsionnyi rezhim naklonnykh poverkhnostei).** K. Ia. Kondrat'ev, Z. I. Pivovarova, and M. P. Fedorova. Leningrad, Gidrometeoizdat, 1978. 216 p. 140 refs. In Russian.

The work reviews the published literature on the solar radiation regimes of inclined surfaces of different orientation. Methods for computing direct, diffuse, reflected, and total solar radiation as well as radiation balance on vertical and inclined surfaces are presented for different climate zones of the globe. Tables listing the radiation characteristics of inclined and vertical surfaces are presented. The work is of use in the fields of agriculture and solar energy engineering. B.J.

**A79-26372 \*** Continuous extrusion of coal. C. England, R. Kushida, and C. Daksa (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *Chemical Engineering Progress*, Aug. 1978, p. 92-94.

A feeding method for use with bituminous coals that exhibit plasticity at elevated temperatures is described and demonstrated on a small screw extruder previously used to extrude polyethylene. A metered feed of coal heated to a temperature just below that of incipient caking (approximately 450°C) is used. Modifications to the extruder consisting of ceramic band heaters, auxiliary cooling coils on the thrust bearing and special quick opening dies are detailed. Coals successfully extruded include high volatile A bituminous coals, high volatile B bituminous coals, a high volatile C bituminous coal and a coal with high ash content. The computer program, EXTRUD, used to simulate the extruder is described. Predicted power consumption exhibits 30% scatter, which is explained by the sensitivity of the coal friction coefficient to temperature profiles. Detailed analysis reveals some discrepancies in the program that need to be resolved. A.L.W.

**A79-26374 \*** Burn coal cleanly in a fluidized bed - The key is in the controls. J. A. Kobak (NASA, Lewis Research Center, Cleveland, Ohio). *Instruments and Control Systems*, Jan. 1979, p. 29-32.

The fluidized-bed combustion (FBC) process produces few sulfur emissions, and can burn wood, municipal solid waste as well as every kind of coal available in the U.S. The pressurized, coal-burning fluidized-bed reactor at NASA's Lewis Research Center is described, together with a discussion of the operating results. The FBC system at Lewis, having a completely instrumented reactor, is used to test turbine blade alloys for future power plant applications. With the same type of coal and limestone used in the first testing phase covering 136 hours, it was found that all NO<sub>x</sub> values were below the EPA standard of 0.7 lb/MBtu, whereas the maximum observed level of SO<sub>2</sub> was above the EPA standard of 1.3 lb/MBtu, but with the average SO<sub>2</sub> level, however, only 0.63 lb/MBtu. Unburned hydrocarbon and CO levels were very low, indicating combustion efficiencies of close to 99% in almost all tests. Testing is now underway using high temperature cyclones and gas turbine to eliminate erosion and corrosion effects which were observed after the initial tests on the turbine and blades. A.A.

**A79-26402 Energy development (Développement énergétique).** M. Schneider-Maunory (Société Nationale Elf-Aquitaine, Paris, France). (*Congrès Mondial de Planification*, 7th, London, England, Sept. 25, 1978.) *Revue de l'Energie*, vol. 30, Jan. 1979, p. 9-16. In French.

Some possible solutions to the world energy problems are discussed including reduction in energy demand and the more efficient production and use of fossil fuels. The development of alternative energy sources is also briefly discussed. It is suggested that the world energy prospects are rather bright in the long term (about the year 2050) but rather bleak in the middle term (up to the year 2000). B.J.

**A79-26403 Energy policy of the European Economic Community (La politique énergétique de la Communauté Economique Européenne).** J. Carrié. *Revue de l'Energie*, vol. 30, Jan. 1979, p. 17-23. In French.

A general overview of the energy policy of the EEC is presented without going into specific energy technologies. Subjects discussed include energy economics, the substitution of oil by other fuels, and international cooperation to assure continued energy imports. B.J.

**A79-26404 Fuels of the future. I (A propos des carburants du futur. II).** M. Grenon. *Revue de l'Energie*, vol. 30, Jan. 1979, p. 32-37. In French.

General problems of energy demand are examined along with such possible solutions as synthetic fuels and primary sources of energy (hydroelectric, geothermal, nuclear and solar). Special consideration is given to the development of methanol- and hydrogen-based fuels. B.J.

**A79-26462 Wilson parameters for the system H<sub>2</sub>, N<sub>2</sub>, CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>S, CH<sub>3</sub>OH, and H<sub>2</sub>O.** J. J. Davis and R. I. Kermode (Kentucky University, Lexington, Ky.). *Fuel Processing Technology*, vol. 1, Oct. 1978, p. 247-259. 68 refs. NSF Grant No. AER-03259-A03.

Parameters for the Wilson equation have been determined for 24 of the 28 binary pairs in the system: H<sub>2</sub>, N<sub>2</sub>, CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>S, CH<sub>3</sub>OH, and H<sub>2</sub>O. The data for eleven pairs were fit using the symmetric convention, with the remaining pairs satisfying the unsymmetric convention. Coefficients for the missing pairs could be estimated from Henry's Law constants. References have been included for the heat capacities of liquid methanol and carbon dioxide. Heats of mixing were also found in the literature. This information, plus readily available gas heat capacities, provides sufficient information to calculate multi-component material and energy balances for the columns used in the separation of H<sub>2</sub>S and CO<sub>2</sub> by cold methanol absorption. (Author)

**A79-26463 Factors affecting bitumen recovery by the hot water process.** J. G. Speight and S. E. Moschopedis (Alberta Research Council, Fuel Sciences Div., Edmonton, Canada). *Fuel Processing Technology*, vol. 1, Oct. 1978, p. 261-268. 10 refs.

The development of the Athabasca oil sands has become one of the major advances of the petroleum industry but the environmental impact of this gigantic processing scheme has been a cause of some concern. The present study investigates factors such as pH, cation types and surface active substances which may seriously affect the hot water process and the disposal of clays into the tailings pond. (Author)

**A79-26464 Mössbauer spectroscopy of iron in coal and coal hydrogenation products.** B. Keisch (Carnegie-Mellon University, Pittsburgh, Pa.), G. A. Gibbon, and S. Akhtar (U.S. Department of Energy, Pittsburgh Energy Research Center, Pittsburgh, Pa.). *Fuel Processing Technology*, vol. 1, Oct. 1978, p. 269-278. 28 refs.

**A79-26465 Catalytic hydrodesulfurization and liquefaction of coal - Batch autoclave studies.** J. Scinta and S. W. Weller (New York, State University, Buffalo, N.Y.). *Fuel Processing Technology*, vol. 1, Oct. 1978, p. 279-286. 13 refs. Research supported by Texaco and ERDA.

The hydrodesulfurization and liquefaction of a high sulfur West Virginia coal has been studied in batch autoclave experiments with tetralin and several Co-Mo-Al<sub>2</sub>O<sub>3</sub> catalysts. Monolith catalysts made from Corning monolith aluminas have been studied in three configurations. The most favorable liquefaction and desulfurization were obtained with a nominal configuration of 200 square cells/sq in. Four particulate catalysts made from controlled pore size aluminas were studied in two sets of experiments. Significant differences in the effects of pore size and stirring rate for sulfided and not-sulfided catalyst were observed. The most favorable distributions were obtained with a large pore, unsulfided catalyst at a low stirring rate and a small pore, sulfided catalyst at a high stirring rate. (Author)

**A79-26466** Coal gasification studies. I - Single stage complete gasification of coal using water as the hydrogen source. R. Butler and A. Snelson (IIT Research Institute, Chicago, Ill.). *Fuel Processing Technology*, vol. 1, Oct. 1978, p. 297-304. 11 refs. Research supported by the Consolidated Natural Gas Service Co.

The complete gasification of coal to low molecular weight hydrocarbons has been achieved in a single stage process using water as the source of hydrogen. Reaction times of one hour, and a temperature of 600°C were required. The reactions were carried out in a stainless steel reactor with iodine or FeI<sub>2</sub> as a catalyst. It is shown that FeI<sub>2</sub> is a catalyst for the reaction stainless steel + H<sub>2</sub>O yields H<sub>2</sub> + metal oxide and also for the coal hydrogenation reaction. The apparent excellent reduction efficiency is probably a consequence of the good contact between the coal sample and the catalyst, which at the reaction temperature has a significant vapor pressure. (Author)

**A79-26467** A mass and energy balance of a Wellman-Galusha gasifier. O. J. Hahn, D. P. Wesley, B. A. Swisshelm, S. Maples (Kentucky, University, Lexington, Ky.), and J. Withrow (National Lime and Stone Co., Carey, Ohio). *Fuel Processing Technology*, vol. 2, Feb. 1979, p. 1-16. 11 refs.

A test was run on a commercial-size, moving-bed atmospheric gasifier to collect process data and to quantify trace gases with a coking bituminous coal (free swelling index /FSI/ 3 to 5). These data were desired to update and expand the available information used in the design of new gas producers and associated gas cleanup systems. The test runs were made with a sized 3.5 x 5 cm (1.5 x 2 inch) Eastern Kentucky Elkhorn No. 3 bituminous coal. As expected, the carbon utilization was high exceeding 99%, the heating value of the gas was 5.6 MJ/cu m; and the cold and hot gas efficiencies were 77% and 87%, respectively. The trace gases quantified were hydrogen sulfide (0.10%), ammonia (0.09%), and hydrogen cyanide (0.0052%). Cyclone dust was examined using a scanning electron microscope and found to be porous. (Author)

**A79-26468** Coal gasification studies. II - Reduction in the presence of I<sub>2</sub> with H<sub>2</sub>, and H<sub>2</sub>O/+ metal, at pressures up to 3500 p.s.i. and temperatures of 600°C in all quartz reactors. R. Butler and A. Snelson (IIT Research Institute, Chicago, Ill.). *Fuel Processing Technology*, vol. 2, Feb. 1979, p. 17-34. 22 refs. Research supported by the Consolidated Natural Gas Service Co.

**A79-26469** Bituminous coal extraction in terms of electron-donor and -acceptor interactions in the solvent/coal system. A. Marzec, M. Juzwa, K. Betlej, and M. Sobkowiak (Polish Academy of Sciences, Dept. of Petroleum and Coal Chemistry, Gliwice, Poland). *Fuel Processing Technology*, vol. 2, Feb. 1979, p. 35-44. 22 refs.

Experiments on high volatile bituminous coal extraction at ambient temperature have been carried out by means of 18 solvents having their electron-donor and -acceptor properties quantitatively determined (DN and AN numbers) by Gutmann's method. A model for coal extraction, based on the assumption that donor-acceptor bonds occur in coal and are responsible for binding together macromolecular networks and extractable substances filling the pores of a network, has been worked out and verified on the basis of experimental data. The results lead to the conclusion that extraction is, in principle, a substitution reaction: pore substances are replaced by a solvent molecule in their donor (network)-acceptor (pore substance) or donor (pore substance)-acceptor(network) bonds. Solvents capable of substitution are characterized by specific DN and AN values. (Author)

**A79-26470** Coke formation on hydrodesulphurization catalysts. M. Ternan, E. Furimsky, and B. I. Parsons (Department of Energy, Mines and Resources, Energy Research Laboratories, Ottawa, Canada). *Fuel Processing Technology*, vol. 2, Feb. 1979, p. 45-55. 16 refs.

The extent of coke formation was measured on a number of different hydrodesulphurization catalysts, primarily as a function of the catalyst chemical composition. Variations in the concentration of MoO<sub>3</sub> on the alumina, the type of catalyst promoter, the promoter/MoO<sub>3</sub> ratio, the presulphiding material and the reaction temperature were made. Increases in the reaction rate caused by either changes in the catalyst composition or by moderate changes in the reaction temperature were compared to the catalyst coke content. It was suggested that two types of coke were present on the catalyst, a reactive coke which is subsequently converted to reaction products and an unreactive coke which blocks catalytic sites. (Author)

**A79-26497** Cavity-type surfaces for solar collectors. F. Demichelis and G. Russo (Torino, Politecnico, Turin, Italy). *Applied Physics*, vol. 18, Mar. 1979, p. 307-309. 11 refs. Research supported by Fiat S.p.A.

The optical shape of the heater's surface of solar energy concentrating collectors is here examined. Multireflection effect, through a macrocavity analysis is introduced. The optical design of the cavity is accomplished and the cavity effect determined. Thermotechnical analysis of the system, in order to determine the optimal conditions for the heat transfer and for the maximization of the energy radiative balance, is introduced. (Author)

**A79-26523** # Three-dimensional effects of electrode configuration on diagonal MHD generator performance. T. Hara and J. Umoto (Kyoto University, Kyoto, Japan). *Journal of Energy*, vol. 3, Jan.-Feb. 1979, p. 16-22. 12 refs. Research supported by the Kawakami Foundation.

The configuration effects of conducting sidewall (DCW) and insulating sidewall (ISW) on the performance characteristics of diagonal-type generators are studied analytically. Three-dimensional potential and current distributions in the channels of these two types are calculated by the finite method (FEM). It is shown that the number of mesh points can be reduced by the FEM in comparison with the finite-difference method in order to provide the same accuracy of the solutions. For cold-wall generators, the DCW channel is found to be superior to the ISW channel with respect to the electrical performances, and vice versa for hot-wall generators. A critical wall temperature, at which the power density vs wall temperature curves of these two types of generators intersect, is found to be dependent on the boundary-layer thickness, the pitch length, and the diagonal angle. (Author)

**A79-26524** # Performance of a closed-cycle MHD generator with molecular impurities. M. Zlatanovic, A. Veefkind, and L. H. T. Rietjens (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands). *Journal of Energy*, vol. 3, Jan.-Feb. 1979, p. 23-29. 14 refs.

The influence of small amounts of molecular impurities on the properties of a noble-gas alkali-seeded MHD plasma has been investigated theoretically and experimentally. The theory has been used to calculate the apparent electrical conductivity, the electron temperature, the electron number density, and the vibrational temperature in a stationary, homogeneous argon-cesium MHD plasma with addition of nitrogen. The agreement between theory and experiment was found to be reasonable. Two kinds of molecular impurities, N<sub>2</sub> and CO<sub>2</sub>, have been studied experimentally as the contaminants in a shock tube MHD generator. In two series of experiments, one at low and one at high stagnation temperature, the concentration of N<sub>2</sub> was varied over the range 0-2% and the concentration of CO<sub>2</sub> over the range 0-0.4%. In all cases the magnetic field was 3 T. The amounts of impurities which cause a reduction in electrical power output of about 30-40% were found to be the following: at low stagnation temperature, 2000-4000 ppm N<sub>2</sub> and 80-120 ppm CO<sub>2</sub>; at high stagnation temperature, 8000-9000 ppm N<sub>2</sub> and 700-1000 ppm CO<sub>2</sub>. The current distribution in the channel, the electron temperature, and number density as well as the apparent electrical conductivity were measured. (Author)

**A79-26538 Sampling and analysis of synthetic fuel processes.** P. S. Dzierlenga, F. G. Mesich, and R. A. Magee (Radian Corp., McLean, Va.). *Environmental Science and Technology*, vol. 13, Mar. 1979, p. 288-293.

It is argued that sampling a synthetic fuel process and obtaining meaningful results is not a routine procedure and cannot be approached casually. The major requirements for a successful sampling effort are careful planning prior to the test effort, including the development of a good sampling plan and the use of an experienced, professional staff capable of efficiently executing the test plan and making in-field decisions to adjust to process changes and unanticipated problems. Planning prior to the test effort involves determining the scope of the sampling effort, analyzing the process to be sampled, selecting sampling and analytical procedures, and designating the program data evaluation requirements. B.J.

**A79-26595 # Radiation energy conversion in space.** K. W. Billman (NASA, Ames Research Center, Materials and Physical Sciences Branch, Moffet Field, Calif.). *Astronautics and Aeronautics*, vol. 17, Mar. 1979, p. 18-26.

Topics discussed at the third NASA conference on radiant energy conversion are reviewed. The unconcentrated-photovoltaic-generation version of a solar power satellite is described, noting that it will consist of a 21.3 x 5.3-sq-km silicon-solar-cell array expected to provide 17 Gw of electrical power, with 1 km in diam transmitters oriented to beam 2.45 GHz microwave power to two receiving/rectifying 'rectennas' on earth. The Solares space-energy-system concept, designed for providing a large fraction of the world's energy needs at costs comparable to those of future coal/nuclear alternative, is considered, as are subsystems for improving the economics of the solar power satellite. A concept proposing the use of relativistic-electron-storage rings for electron-beam energy transmission and storage, and a report on the production of a high temperature plasma with concentrated solar radiation are taken into account. Laser-conversion systems, including the direct-solar-pumped space laser, and the telec-powered spacecraft, are discussed. A.A.

**A79-26596 # Power from space by laser.** C. N. Bain. *Astronautics and Aeronautics*, vol. 17, Mar. 1979, p. 28-40. 73 refs.

High-powered lasers projected for application to a satellite power system are reviewed. The chemical laser, combining an oxidizer and fuel to produce a high-density chemical reaction, is considered, as is the gasdynamic type. The electric-discharge laser (EDL) in which a high-temperature, high-pressure gas is expanded through a supersonic nozzle, is described, noting that the most recent models use the fast-flow N<sub>2</sub>-CO<sub>2</sub> technique, with an electron beam controlling the discharge. Beam shaping is examined in relation to energy propagation, together with a discussion of the principal factors affecting the propagation of high-powered laser beams. Refractors/mirrors as well as adaptive optics for correcting errors resulting from vibration, flexure, and initial fabrication are taken into account. The relationship between power output and waste heat, the laser efficiency and costs, as well as mass-to-power ratios for various laser power transmission systems (LPTS) are analyzed. It is concluded that the development of an LPTS able to handle the satellite power appears technologically feasible using scaling and phased-array techniques. A.A.

**A79-26597 # Laser aircraft.** A. Hertzberg, K. Sun (Washington, University, Seattle, Wash.), and W. S. Jones (Lockheed Research Laboratories, Palo Alto, Calif.). *Astronautics and Aeronautics*, vol. 17, Mar. 1979, p. 41-49. 22 refs. Grant No. NGL-49-002-044.

The concept of a laser-powered aircraft is discussed. Laser flight would be completely compatible with existing airports and air-traffic control, with the airplane using kerosene only power, up to a cruising altitude of 9 km where the laser satellite would lock on and beam laser energy to it. Two major components make up the laser turbofan, a heat exchanger for converting laser radiation into thermal energy, and conventional turbomachinery. The laser power satellite would put out 42 Mw using a solar-powered thermal engine to

generate electrical power for the closed-cycle supersonic electric discharge CO laser, whose radiators, heat exchangers, supersonic diffuser, and ducting will amount to 85% of the total subsystem mass. Relay satellites will be used to intercept the beam from the laser satellite, correct outgoing beam aberrations, and direct the beam to the next target. A 300-airplane fleet with transcontinental range is projected to save enough kerosene to equal the energy content of the entire system, including power and relay satellites, in one year. A.A.

**A79-26599 # Solar power satellites - The laser option.** W. S. Jones and M. W. Hunter, II (Lockheed Research Laboratories, Palo Alto, Calif.). *Astronautics and Aeronautics*, vol. 17, Mar. 1979, p. 59, 67.

The option of using laser- instead of microwave beams in solar power systems is explored. The advantages of small transmitter aperture associated with lasers, whose wavelength is up to four times smaller than microwave, are considered, noting that the weight of the laser-transmitting aperture does not dominate the system. Possible damages arising from the use of microwaves and lasers in solar power systems are analyzed, concluding that lasers, in contrast to microwaves, affect only the surface of organisms, thus making assessment and control easier. A.A.

**A79-26623 Climatic change in connection with energy growth (Klimänderung durch Energiewachstum).** W. Bach (Münster, Universität, Münster, West Germany). *Brennstoff-Wärme-Kraft*, vol. 31, Feb. 1979, p. 49-56. 51 refs. In German.

Changes regarding the local and regional climate can be produced as a consequence of the technical and economical activities of man. It is probable that the continuing growth regarding the consumption of energy will also have an effect on the global climate. It is likely that such an effect will not be distinguishable from changes related to natural climatic fluctuations before the year 2000. It is, however, not advisable to wait until nature itself shows the effects produced as a consequence of the human activities, because these effects might be irreversible. In addition, time periods from at least 25 to 50 years are required for the occurrence of structural changes in the energy consumption pattern. It is, therefore, necessary to study the possible relations between human activities and the climate with the aid of models and scenario analyses. Approaches for doing this are discussed, taking into account various energy sources and energy strategies. G.R.

**A79-26624 The potential of fusion reactors as process heat source (Das Potential von Fusionsreaktoren als Prozesswärmekquelle).** H. Brockmann, H. Clermont, J. Darvas, S. Förster, H. F. Niessen, U. Ohlig, P. Quell, and B. Sack (Kernforschungsanlage Jülich GmbH, Institut für Reaktorentwicklung, Jülich, West Germany). *Brennstoff-Wärme-Kraft*, vol. 31, Feb. 1979, p. 61-66. In German.

It is illustrated with the aid of selected examples that fusion reactors can provide at the same time an energy source for electric power generation and a heat source for industrial chemical processes. The generation of superheated steam and the thermal decomposition of sulfuric acid are considered. The steam can either be used for the production of substitute natural gas from coal or for electric power generation with a high efficiency. The sulfuric-acid process in combination with an electrolysis procedure is employed for the production of hydrogen gas from water. Advantages of the considered approaches are related to the possibility to produce energy carriers which can be stored in addition to electrical power, for which the demand is subject to temporal fluctuations. G.R.

**A79-26723 # Evaluation of the effectiveness of electric power systems for transport purposes (Otsenka effektivnosti oborudovaniia elektroenergeticheskikh sistem transportnykh sredstv).** V. I. Kriventsev. *Akademiiia Nauk SSSR, Izvestiia, Energetika i Transport*, Jan.-Feb. 1979, p. 123-132. 5 refs. In Russian.

An analytical method is proposed for determining correction

factors for evaluating the changes in the operational and economic indices that characterize the effectiveness of using electric power systems for transport purposes over limited periods of time. The expressions for the correction factors also can be used to determine some technological-economical indices. For illustration, the method is applied to a practical example.

V.P.

**A79-26747** Diagnostics of Shiva Nova high-yield thermonuclear events. H. G. Ahlstrom, L. W. Coleman, F. Rienecker, Jr., and V. W. Slivinsky (California University, Livermore, Calif.). *Optical Society of America, Journal*, vol. 68, Dec. 1978, p. 1731-1741. 28 refs. Contract No. W-7405-eng-48.

Experiments with the Shiva Nova laser facility which produce yield levels of scientific break-even and above will result in neutron, X-ray, and particle fluxes which will require specific attention to the survivability of diagnostic instrumentation. These yield levels will also allow the utilization of new diagnostics techniques which can provide detailed information on the state of the imploded fuel and pusher shells.

(Author)

**A79-26815** Design considerations for residential solar heating and cooling systems utilizing evacuated tube solar collectors. D. S. Ward and J. C. Ward (Colorado State University, Fort Collins, Colo.). *Solar Energy*, vol. 22, no. 2, 1979, p. 113-118. 7 refs.

Evacuated tube solar collectors permit the use of a vacuum of sufficient magnitude to virtually eliminate convection and conduction heat transfer losses. These collectors generally require a minimum amount of material per sq m of collector and thus provide for the possibility of lower costs. The vacuum may help protect a selective surface used on the absorber against performance degradation over the life of the collector. Variations in the design of evacuated tube solar collectors are discussed. The design and performance of a solar heating/cooling system (liquid system) and of a cooling subsystem are outlined. An obvious conclusion is the advantages associated with the use of air as the collector fluid, with the result that freezing, boiling and corrosion difficulties occurring with liquid systems are eliminated.

S.D.

**A79-26816** Efficient Fresnel lens for solar concentration. E. M. Kritchman, A. A. Friesem, and G. Yekutieli (Weizmann Institute of Science, Rehovot, Israel). *Solar Energy*, vol. 22, no. 2, 1979, p. 119-123. 13 refs.

The paper discusses a new design for a two-dimensional concave Fresnel lens which, while having grooves facing down to prevent 'blocking', is capable of maintaining high concentration even for large acceptance angles. The design resembles the 'ideal' concentrating mirrors reported by Winston (1970). The discussion is restricted to the two-dimensional case of linear concentrating elements where the sun is in the plane transverse to the linear axis. However, the treatment can be readily extended to circular elements.

S.D.

**A79-26817** Performance of combined solar-heat pump systems. T. L. Freeman, J. W. Mitchell, and T. E. Audit (Wisconsin University, Madison, Wis.). *Solar Energy*, vol. 22, no. 2, 1979, p. 125-135. 15 refs.

The study analyzes the thermal performance of three types of combined solar-heat pump systems: (1) a series system in which the solar storage is used as the source for the heat pump; (2) a parallel system in which ambient air is used as the source for the heat pump; and (3) a dual source system in which the solar storage or ambient air is used as the source, depending on which source yields the lowest work input. These combined systems are compared with conventional solar and heat-pump systems. The parallel combined system appears to be the most practical solar-heat pump system configuration over the heating season. Costs and the extent to which summer cooling is a requirement determine the relative merit of the parallel system, along with the conventional solar and heat-pump systems.

S.D.

**A79-26818** Heat loss characteristics of an evacuated plate-in-tube collector. G. T. Roberts (Polytechnic of Wales, Pontypridd, Wales). *Solar Energy*, vol. 22, no. 2, 1979, p. 137-140.

A theoretical-experimental study is conducted to evaluate the heat loss from an absorber plate placed inside a partially evacuated glass tube. Experimental results are compared with those of a theoretical model of the system. The effect of introducing a gas of low thermal conductivity is assessed. A diagram is presented, showing the expected efficiency of a tube containing methyl iodide placed in an insulating block with cover reflection losses taken to be 16%, together with values of collector efficiency for other evacuated tube systems reported by McVeigh (1977). Advantageous characteristics, in addition to low heat loss, are mentioned.

S.D.

**A79-26819** Design and optimisation of an absorption refrigeration system operated by solar energy. S. Alizadeh, F. Bahar, and F. Geoola (Arya Mehr University of Technology, Teheran, Iran). *Solar Energy*, vol. 22, no. 2, 1979, p. 149-154. 8 refs.

A general theoretical study on design and optimization of the water-lithium bromide and the ammonia-water absorption refrigeration cycles has been undertaken. The results of this study show that in general for fixed initial conditions and given system refrigeration capacity higher generator temperature causes higher cooling ratio with smaller heat exchange surfaces and consequently lower cost. A comparison of the two cycles also indicate that the water-lithium bromide system is simpler than the ammonia-water system and operates at a higher cooling ratio and smaller heat exchange surfaces for the same conditions.

(Author)

**A79-26822** The effect of the dispersion of the characteristics of solar cells in large systems. A. Luque and E. Lorenzo (Escuela Técnica Superior de Ingenieros de Telecommunicación, Madrid, Spain). *Solar Energy*, vol. 22, no. 2, 1979, p. 187-189.

The random variation of the characteristics of a solar cell affects the maximum power obtainable from an array of cells. The study presents a theoretical model that relates the loss in array power to the mean value and standard deviation of the open-circuit voltage, short-circuit current and series resistance of individual cells. Both series- and parallel-connected arrays are considered. It is shown that the decrease in the efficiency of an array of solar cells is proportional to a function that represents the deviation between the mean and the minimum values of a normal variable. This function decreases with increasing number of array cells. Other formulas for array efficiency are also presented.

S.D.

**A79-26823** Screening reversible reactions for thermochemical energy transfer. O. M. Williams and P. O. Carden (Australian National University, Canberra, Australia). *Solar Energy*, vol. 22, no. 2, 1979, p. 191-193. 5 refs.

Wentworth and Chen (1976) have introduced a convenient parameter, the turning temperature, for assessing the suitability of reversible chemical reactions for use in solar thermochemical energy transfer systems. The turning temperature is defined as the temperature at which neither reactant nor product formation is thermodynamically favored, and can be estimated to a good approximation from standard thermodynamic data alone. However, this approach applies only to systems operated at 1-atm pressure and is therefore unsuitable for assessing high-pressure reactions such as the ammonia dissociation/synthesis or the equivalent methanol reaction. The present note shows that the definition of the turning temperature may be modified to cover high-pressure reactions. An alternative characteristic temperature, the neutral equilibrium temperature, which defines more precisely the midpoint of a thermochemical energy transfer reaction is introduced. A discussion of the thermodynamic significance of the turning temperature shows that it serves as a useful guide to the thermodynamic limitations of proposed thermochemical energy transfer systems.

S.D.

**A79-26947** The iron-titanium - hydrogen system: A transmission electron microscope /TEM/ study. T. Schober (Kernfor-

schungsanlage Jülich GmbH, Institut für Festkörperforschung, Jülich, West Germany). *Scripta Metallurgica*, vol. 13, Feb. 1979, p. 107-112. 20 refs.

A transmission electron microscope (TEM) study of the hydrogenation of FeTi using high purity materials is presented. Hydrogen charging of the ingot samples was accomplished by using either one of these specially developed techniques: immersion of FeTi in dilute HCl (3.6%) at 60°C, or electrolytic charging of 3 mm ingot disks in very dilute H<sub>2</sub>SO<sub>4</sub> at 20°C and low currents. The two charging methods were found to circumvent the problems of oxidation and surface segregation and allow the study of FeTi-hydrides under highest purity conditions. It is shown that TEM techniques may be successfully applied to the study of hydrides useful for hydrogen storage. A.A.

**A79-26958 Contribution to the development of wind energy systems using static power electronic converters.** V. Rajagopalan and D. Veillette (Québec, Université, Trois-Rivières, Canada). In: PESC '78: Power Electronics Specialists Conference, Syracuse, N.Y., June 13-15, 1978, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 69-75. Research supported by the Department of Energy, Mines and Resources, National Research Council of Canada, and Université du Québec.

A wind energy system, using a squirrel cage induction machine and a static power electronic conversion equipment, incorporating a novel and economical pulse frequency modulated three phase auxiliary impulse commutated inverter, is described. A complete description of the proposed power as well as control schemes is given, with special reference to its possible application in variable speed wind power conversion scheme. Experimental results obtained on a laboratory breadboard of the power electronic conversion equipment for a 2 KVA, 208 V, 60 Hz, 3 phase squirrel cage, inverter fed induction machine in self excited mode of operation with a 3 to 1 speed range, are reported. (Author)

**A79-26995 Low voltage behavior of lithium/metal dichalcogenide topochemical cells.** D. W. Murphy and J. N. Carides (Bell Telephone Laboratories, Inc., Murray Hill, N.J.). *Electrochemical Society, Journal*, vol. 126, Mar. 1979, p. 349-351. 10 refs.

**A79-26996 Discharge characteristics of a soluble iron-titanium battery system.** R. F. Savinell, C. C. Liu, R. T. Galasco, and S. H. Chiang (Pittsburgh, University, Pittsburgh, Pa.). *Electrochemical Society, Journal*, vol. 126, Mar. 1979, p. 357-360. 12 refs. Research supported by the Alcoa Foundation.

Constant-load and constant-current discharge data are presented for a soluble iron-titanium electrochemical system. Output performance is limited mainly by activation polarization in the anodic reaction, Ti(III) - e(-) yields Ti(IV). The influence of different electrode materials, including platinum, graphite foil, and titanium-base electrodes, and of temperature was investigated. (Author)

**A79-27207 Superbatteries - A progress report.** J. R. Birk (Electric Power Research Institute, Palo Alto, Calif.), K. Klunder, and J. C. Smith (U.S. Department of Energy, Washington, D.C.). *IEEE Spectrum*, vol. 16, Mar. 1979, p. 49-55.

Future batteries, known as superbatteries, expected to be used as replacements for scarce fuel sources in the utilities and transportation sectors, are discussed. The sodium-sulfur model is considered as an example, noting that while the lead-acid battery, as almost all conventional batteries, contains solid electrodes and a liquid electrolyte, the sodium-sulfur contains liquid electrodes and a solid electrolyte, which makes for longer life. Progress in designing inexpensive and well performing lead-acid batteries is taken into account, emphasizing the development of seals using bonding by thermal compression, and of high-quality beta-alumina electrolyte tubes. The performance of electric vehicles is noted, together with a description of the various requirements facing the battery designer, including cruise speed, acceleration, and engine life. Cost problems impeding the full-scale development and commercialization of superbatteries are mentioned. A.A.

**A79-27208 No ill winds for New Mexico utility.** T. W. Reddoch (Tennessee, University, Knoxville, Tenn.) and J. W. Klein (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *IEEE Spectrum*, vol. 16, Mar. 1979, p. 57-61.

The NASA experimental 200 kW wind generator at Clayton, N.M., is discussed. A microprocessor as well as 256 bytes of RAM, 2 kbytes of EPROM, and related circuitry maintain synchronism and constant power output by handling start-up and shutdown control, alignment of the rotor assembly with wind direction, and protection against abnormal operating and environmental conditions. The system frequency has a characteristic natural mode of oscillation (Fourier component) at 3 Hz, with the wind-turbine frequency being the same, even though some recording noise does exist on the system frequency channel. The data from the first months of operation indicate that the experimental wind generator has performed superbly in an electrical environment having both significant variations in frequency (+ or - 0.5 Hz) and power swings on the output from conventional generation. A.A.

**A79-27213 Solar energy application of natural zeolites.** D. I. Tchernev (MIT, Lexington, Mass.). In: *Natural zeolites: Occurrence, properties, use*. Oxford, Pergamon Press, Ltd., 1978, p. 479-485. NSF-supported research.

The utilization of solar energy for cooling is usually achieved by means of sorption-refrigeration cycles. However, the conventional cycles using ammonia-water or lithium bromide-water solutions are inefficient because of the low solution temperatures obtainable with solar radiation and the high condenser temperatures required by air-cooled condensers. Zeolites provide a unique opportunity for a solid-gas adsorption cooling system because of their extremely nonlinear-adsorption isotherms. We have demonstrated the feasibility of using a zeolite system to provide domestic hot water and space heating with overall efficiencies above 75% and space cooling with an overall efficiency above 50%. The system uses natural chabazite or clinoptilolite as the solid adsorber and water vapor as the working fluid. The operation of the system is described and the experimental results are discussed. Preliminary estimates indicate that such a system will be economically competitive. (Author)

**A79-27219 Induction-generator/synchronous-condenser system for wind-turbine power.** B. T. Ooi and R. A. David (McGill University, Montreal, Canada). *Institution of Electrical Engineers, Proceedings*, vol. 126, Jan. 1979, p. 69-74. 18 refs. National Research Council of Canada Grant No. A-7784.

A novel wind-turbine-driven electric power system for isolated communities is described. The system components consist of an induction generator and a synchronous condenser. The synchronous condenser supplies the magnetisation current to the induction generator. Besides supplying the load power, the induction generator feeds the synchronous condenser with real power to replenish windage, friction and I<sub>2</sub>R losses to sustain it at synchronous speed. The theory of operation is given, and predictions based on it are experimentally verified. The controllers required to maintain regulated voltage and frequency in spite of load and wind velocity changes are investigated. Slip-energy recovery is involved, and preliminary test results are presented. (Author)

**A79-27302 # Calculation and design of liquid-metal MHD induction machines (Raschet i proektirovanie induktsionnykh MGD-mashin s zhidkometallicheskim rabochim telom).** G. A. Baranov, V. A. Glukhikh, and I. R. Kirillov. Moscow, Atomizdat, 1978. 248 p. 189 refs. In Russian.

Fundamental principles relating to the theory and design of liquid-metal MHD induction pumps and generators are discussed. Particular attention is given to the large body of experimental studies on electromagnetic and hydrodynamic processes in such machines. The construction of MHD machines with flat, helical and cylindrical channels is described. Optimal design considerations are presented.

B.J.

**A79-27317** A proposed thermophotovoltaic solar energy conversion system. R. M. Swanson (Stanford University, Stanford, Calif.). *IEEE, Proceedings*, vol. 67, Mar. 1979, p. 446, 447. 11 refs. Research supported by the Stanford University and Electric Power Research Institute.

A solar-electric system is proposed and discussed. This system uses concentrated mirrors focusing on a thermophotovoltaic (TPV) converter. Within the TPV converter the concentrated sunlight heats a refractory radiator. A silicon photovoltaic cell faces the radiator, receives incandescent radiation from it, and converts this radiation into electricity. (Author)

**A79-27327** Wind energy. B. Wolff (American Wind Energy Association, Washington, D.C.) and H. Meyer (Windworks, Mukwonago, Wis.). Philadelphia, Pa., Franklin Institute Press, 1978. 82 p. 39 refs. \$6.50.

The 1972 Solar Energy Panel of NASA and the National Science Foundation estimated the potential wind power available in the U.S. to be about 100,000 gigawatts, which is 30 times greater than the projected energy consumption for 1980. Wind energy is discussed with a view of providing a practical foundation and guide to the analysis and application of wind energy conversion systems. The basic theory is set forth, considering drag and lift translators, power extraction, tip speed ratio and solidity, as well as optimum blade design. Wind energy conversion system components are examined, including the momentum exchange and the energy conversion devices, as well as control systems. Methods for estimating energy production are explored, together with a presentation of plots showing wind frequency distribution in arbitrary units, monthly wind variation, and daily wind variation. The wind energy system is discussed with emphasis on economic performance, indicating that the costs of such systems are less uncertain than those of other solar-electric technologies. Studies of wind energy applications are noted, as are environmental considerations. A.A.

**A79-27339 #** Controlled thermonuclear fusion (Upravliaemyi termonuklearnyi sintez). E. P. Velikhov and B. B. Kadomtsev (Akademii Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). In: *Science and mankind: International annual*. Moscow, Izdatel'stvo Znanie, 1978, p. 243-251. In Russian.

The paper reviews the elements of thermonuclear fusion and how scientists are currently at work on achieving controlled fusion to yield useful energy. The types of devices now being studied as possible means for achieving the proper temperatures and confinement times are briefly characterized. The concept of a hybrid reactor, in which a fusion reaction produces fast neutrons which are used to split uranium or thorium to produce an energy-yielding fission reaction, is briefly outlined. P.T.H.

**A79-27345** Run duration analysis of surface wind speeds for wind energy application. A. B. Sigi (South Dakota State University, Brookings, S. Dak.), R. B. Corotis (Northwestern University, Evanston, Ill.), and D. J. Won (Sargent and Lundy Engineers, Chicago, Ill.). *Journal of Applied Meteorology*, vol. 18, Feb. 1979, p. 156-166. 18 refs. Contract No. EY-76-S-06-2342.

Hourly wind speed records are used to develop a model for the probability distribution of wind speed persistence above and below fixed reference speeds. Examination of duration histograms from 19 sites for records varying from 5-24 years leads to the development of a simple composite distribution. Enforcement of smooth behavior and a parameter sensitivity analysis allow the model to be interpreted in terms of a single free parameter, which is then shown to be highly correlated to the seasonal mean wind speed at a site. Comparison of run duration results for 1 and 3 h data (the latter being the standard digitization presently used by the National Climatic Center) indicates a definite bias with the 3 h records. A correction scheme is derived to improve the 3 h results. (Author)

**A79-27372** Principles of solar engineering: F. Kreith (Solar Energy Research Institute, Golden; Colorado, University, Boulder, Colo.) and J. F. Kreider. Washington, D.C., Hemisphere Publishing Corp., 1978. 790 p. 332 refs. \$24.50.

The aim of the book is to present all the information necessary for the design and analysis of solar energy conversion systems. A combination of basic technical understanding and an appreciation of the economic aspects of using nonrenewable energy sources is developed. The divisions of the subject matter are as follows: introduction to solar energy and its conversion, fundamentals of solar radiation, fundamentals of fluid mechanics and heat transfer, methods of solar collection and thermal conversion, system analysis and economics of solar systems, solar heating systems, solar cooling and dehumidification, solar electric power and process heat, and a brief look at natural solar conversion systems such as wind energy, thermal ocean thermal gradient and wave power, and biomass conversion systems.

P.T.H.

**A79-27375 #** Solar power satellite. H. P. Davis (NASA, Johnson Space Center, Houston, Tex.). *American Institute of Chemical Engineers, Annual Meeting*, 71st, Miami Beach, Fla., Nov. 13, 1978, Paper. 19 p. 35 refs.

The solar power satellite (SPS) concept, under evaluation by NASA since 1974, is discussed. A typical system providing a total of 10,000 MW of electrical power to the ground receiving stations is considered. Energy conversion systems, including the photovoltaic device category using single-crystal silicon cells, are taken into account, as are the 2.45-GHz microwave power-transmission link and the ground receiver (or rectenna). Concepts involving space construction of the satellite's large structures (5 x 25 km) are described, noting that a process similar to the familiar roll-forming of light sheet metal parts has been adapted to the space environment. Transportation vehicles are discussed, including the Space Shuttle planned to reach 60 flights per year by the mid 1980's. Electrical power forecasts and advanced systems cost projections are analyzed, together with a description of costs estimates. The indirect economics of energy research and development, and the present NASA/DOE SPS program are noted.

A.A.

**A79-27376** Oceans '78: The ocean challenge; Proceedings of the Fourth Annual Combined Conference, Washington, D.C., September 6-8, 1978. Conference sponsored by the Marine Technology Society and Institute of Electrical and Electronics Engineers. Washington, D.C., Marine Technology Society; New York, Institute of Electrical and Electronics Engineers, Inc., 1978. 766 p. \$60.

Topics related to buoy technology are considered along with acoustic systems, ocean sciences, underwater work systems and procedures, economics and management of coastal regions, instrumentation, fisheries, unmanned underwater vehicles, law and policy, electromechanical cables/connectors and their components, acoustic sources and sonars, the large-scale development of ocean energy resources, remote sensing from satellites and aircraft, institutional aspects of ocean development, satellite radiometric and visible sensing, marine pollution analysis and monitoring, and navigation. Attention is also given to sea floor engineering, information and data systems, education and training for ocean involvement, novel devices for extracting energy from the ocean, deep-sea mining, wave direction measurement technology, and problems concerning the financing of ocean development.

G.R.

**A79-27377** Environmental considerations for siting an ocean thermal conversion early ocean testing platform at four proposed areas. M. D. Sands (Interstate Electronics Corp., Anaheim, Calif.) and P. Wilde (California, University, Berkeley, Calif.). In: *Oceans '78: The ocean challenge; Proceedings of the Fourth Annual Combined Conference*, Washington, D.C., September 6-8, 1978. Washington, D.C., Marine Technology Society; New York, Institute of Electrical and Electronics Engineers Inc., 1978, p. 358-362. 14 refs. Contract No. EG-77-C-06-1033.

## A79-27378

The OTEC concept uses the thermal gradient that naturally exists in the oceans to condense and evaporate a working fluid. OTEC-1 is not scheduled to have a turbine, or produce a net energy gain, but to demonstrate and evaluate various technological concepts. The site that is selected for OTEC-1 testing must be located within 200 nautical miles off the U.S. and its properties. The study sites designated for the considered investigation include Keahole Point, Hawaii; Punta Tuna, Puerto Rico; New Orleans, La.; and the West Coast of Florida. The main considerations for the assessment of potential environmental impacts are dependent upon the near field dispersion of the plume. Once isolopleths are prepared for each contaminant introduced to the environment, applicable toxicity data for resident organisms can be compared. The environmental impacts that are under evaluation include the impacts that may result from trace element leaching from various components of the system. G.R.

**A79-27378** Technology considerations in the design of a commercial offshore energy conversion /OTEC/ plant. W. W. Rogalski, Jr., R. J. Scott (Gibbs and Cox, Inc., Arlington, Va.), and J. G. Giannotti (Giannotti and Buck Associates, Inc., Riverdale, Md.). In: *Oceans '78: The ocean challenge; Proceedings of the Fourth Annual Combined Conference*, Washington, D.C., September 6-8, 1978. Washington, D.C., Marine Technology Society; New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 363-368. 5 refs.

The design and construction of an OTEC plant slated to produce electricity for commercial consumption in the near future presents a number of unique problems and is forcing the advancement of the state of the art in ocean structures in a number of fields. The successful deployment of a commercially viable OTEC plant is dependent upon identifying these technology areas and developing a program to insure that any potential program obstacles are adequately addressed. (Author)

**A79-27389** A wave activated electric generator. T. Omholt (Maritime College, Bronx, N.Y.). In: *Oceans '78: The ocean challenge; Proceedings of the Fourth Annual Combined Conference*, Washington, D.C., September 6-8, 1978. Washington, D.C., Marine Technology Society; New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 585-589. 11 refs.

A large number of devices have been proposed for extracting energy from ocean surface waves. This paper proposes yet another which operates on the same principles as alternating current generators. The device forms a two-degree of freedom mechanical system producing power by electro-magnetic induction. The equations governing the system's motion, as well as, the rate of power generation is presented. These are solved in a special case, which for a typical set of operating conditions, lead to energy extraction from the waves of 35 percent. (Author)

**A79-27390** Energy from sea waves - System optimization by diffraction theory. G. Sebastiani, M. Berta, and A. Blandino (Tecnomare S.p.A., Venice, Italy). In: *Oceans '78: The ocean challenge; Proceedings of the Fourth Annual Combined Conference*, Washington, D.C., September 6-8, 1978. Washington, D.C., Marine Technology Society; New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 590-595. 7 refs.

The paper deals with a computerized method for the determination of the optimal conditions for an efficient extraction of energy from sea waves. The analyzed system is a floating cylinder connected to an energy extracting device. The system has been studied parametrically, by calculating its maximum efficiency in function of the geometric dimensions and layout configuration. The diffraction theory has been used in order to calculate the hydrodynamic terms (forces, added masses, damping coefficients) taking into account the real interaction between the body and the sea. Moreover a true statistic of waves is used in order to compare the efficiency of various systems in real sea conditions. The results obtained have confirmed the possibility of optimizing the system efficiency with respect to the parameters examined. (Author)

**A79-27391** The use of ocean energy - A hydrostatic motor. S. Selwyn and F. W. McCoy (Lamont-Doherty Geological Observatory, Palisades, N.Y.). In: *Oceans '78: The ocean challenge; Proceedings of the Fourth Annual Combined Conference*, Washington, D.C., September 6-8, 1978. Washington, D.C., Marine Technology Society; New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 599-601. NSF Grant No. OCE-76-18049; Contract No. N00014-75-C-0210.

A device which utilizes the hydrostatic gradient at sea is described. The apparatus is currently configured to drive a deep-sea sediment sampler but could be used for virtually any power requirement. A simplified schematic diagram is presented to illustrate the working principle, and sample calculations of the power available are provided. (Author)

**A79-27395 \*** Hot corrosion of Ni-base turbine alloys in atmospheres in coal-conversion systems. T. Huang, E. A. Gulbransen, and G. H. Meier (Pittsburgh University, Pittsburgh, Pa.). *Journal of Metals*, vol. 31, Mar. 1979, p. 28-35. 28 refs. Contract No. E(49-18)-2484; Grant No. NSG-3214.

Alkali-metal contaminants in coal may form low-melting sulfate salts during coal gasification or subsequent combustion which can have very deleterious effects on turbine components. The mechanisms for the hot-corrosion phenomena are not completely understood. (Author)

**A79-27399 #** Performance of a 5 MWt solar steam generator. W. J. Oberjohn and W. T. Southards (Babcock and Wilcox Co., Alliance, Ohio). *American Society of Mechanical Engineers, Joint Power Generation Conference, Dallas, Tex., Sept. 10-14, 1978, Paper*, 23 p. Contract No. E(04-3)-1109.

A radiant heat test was conducted to verify the functional performance of a 5 MWt solar steam generator. The steam generator modeled the essential features of a conceptual design proposed by the Honeywell team for the DOE 10 MWe Solar Pilot Plant. This paper describes the experimental steam generator and its instrumentation. Selected test results and analyses are presented which demonstrate that steam generator performance was predictable, controllable, and responsive. From this, it is concluded that fossil boiler technology can form the basis for a successful solar steam generator design. (Author)

**A79-27400 \* #** The application of hydraulics in the 2,000 kW wind turbine generator. S. Onufrejczuk (General Electric Co., Space Div., Valley Forge, Pa.). *National Conference on Fluid Power and Power Transmission, Philadelphia, Pa., Nov. 7, 1978, Paper*, 16 p. Contract No. NAS3-20058.

A 2000 kW turbine generator using hydraulic power in two of its control systems is being built under the management of NASA Lewis Research Center. The hydraulic systems providing the control torques and forces for the yaw-and blade pitch control systems are discussed. The yaw-drive-system hydraulic supply provides the power for positioning the nacelle so that the rotary axis is kept in line with the direction of the prevailing wind, as well as pressure to the yaw and high speed shaft brakes. The pitch-change-mechanism hydraulic system provides the actuation to the pitch change mechanism and permits feathering of the blades during an emergency situation. It operates in conjunction with the overall windmill computer system, with the feather control permitting slewing control flow to pass from the servo valve to the actuators without restriction. A.A.

**A79-27529** Investigation of the thermophysical characteristics of cryogenic heat pipes with a metal-fiber wick. M. G. Semenà and A. I. Levtorov (Kievskii Politekhnicheskii Institut, Kiev, Ukrainian SSR). *(Inzhenerno-Fizicheskii Zhurnal*, vol. 35, July 1978, p. 48-53.) *Journal of Engineering Physics*, vol. 35, no. 1, Jan. 1979, p. 797-801. 11 refs. Translation.

The experiments described were carried out to study the thermophysical characteristics of liquid-hydrogen heat pipes with fibrous stainless steel and copper wicks. The temperature fields and critical heat fluxes are determined as a function of heat-transfer-agent excess and heat-pipe angle of inclination. The influence of the thermophysical properties of the working fluid and transport properties of the wicks on heat pipe performance is investigated. It is shown that heat pipes of this type exhibit excellent heat transfer characteristics.

V.P.

**A79-27651 Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.** Conference sponsored by the Cryogenic Society of America. Edited by J. R. Missig (Liquid Carbonic Corp., Chicago, Ill.) and R. W. Vance (Cryogenic Society of America, West Rancho Palos Verdes, Calif.). Flushing, N.Y., Scholium International, Inc., 1978. 408 p. \$29.50.

Papers are presented on the implications of cryogenics for hydrogen energy, MHD power generation, and the application of superconducting technology to the energy field. Consideration is also given to military applications of superconductivity and to the application of cryogenic technology to controlled fusion.

B.J.

**A79-27652 Hydrogen via gasification - Today and tomorrow.** P. B. Tarman (Institute of Gas Technology, Chicago, Ill.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.

Flushing, N.Y., Scholium International, Inc., 1978, p. 22-36.

Both the commercially available and emerging technologies for producing hydrogen from coal are summarized. The commercially available technologies which are discussed are the Winkler process, the Koppers-Totzek process, the Lurgi process, and the Wellman-Galusha process. Of the emerging technologies, the Texaco process, the U-gas process and the steam-iron process are discussed, with emphasis on the latter.

B.J.

**A79-27653 Progress in solid polymer electrolyte water electrolysis.** L. J. Nuttall (General Electric Co., Wilmington, Mass.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.

Flushing, N.Y., Scholium International, Inc., 1978, p. 37-51.

The development of solid polymer electrolyte (SPE) technology for use in large-scale hydrogen production applications associated with energy storage and advanced energy systems is discussed. The principles of SPE technology are briefly reviewed and the current status of the SPE program is discussed in terms of reduced cost, improved efficiency, and cell scale-up.

B.J.

**A79-27654 Hydrogen via thermochemistry and future water-splitting technologies.** J. B. Pangborn (Institute of Gas Technology, Chicago, Ill.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.

Flushing, N.Y., Scholium International, Inc., 1978, p. 52-64. 17 refs.

Thermochemical water splitting technology is surveyed with reference to direct thermal splitting of water, thermochemical cycles, hybrid cycles, and the steam-iron process. In addition, other future-technology water-splitting process are discussed including nuclear radiolysis techniques, biomass digestion, and photosynthetic and biochemical hydrogen production.

B.J.

**A79-27655 An overview of the STOR hydrogen energy program.** B. J. Berger (U.S. Department of Energy, Div. of Energy Storage Systems, Washington, D.C.) and W. R. Standley (TRW, Inc., Energy Systems Planning Div., McLean, Va.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978

Flushing, N.Y., Scholium International, Inc., 1978, p. 72-86. 6 refs.

The nonfossil technologies being pursued by the Division of Energy Storage Systems (STOR) include water electrolysis, thermochemical water splitting, and a number of advanced concepts. The long-term objective of STOR is to develop technology to produce hydrogen from water at a cost of less than \$6 per million Btu. Consideration is also given to aspects of hydrogen storage, transmission, and utilization along with intra-DOE and international efforts in this field.

B.J.

**A79-27656 Cryohydrogen-fuel for tomorrow's commercial aircraft.** G. D. Brewer (Lockheed-California Co., Burbank, Calif.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.

Flushing, N.Y., Scholium International, Inc., 1978, p. 87-104. 6 refs.

Studies performed for NASA on the potential use of liquid hydrogen as an aircraft fuel are summarized. Particular consideration is given to a recently completed study on how utilization of LH<sub>2</sub> will affect the design of the engine and fuel system for a representative subsonic passenger transport. It is concluded that adoption of cryohydrogen as the fuel for future commercial aircraft will reduce the need for oil imports, reduce pollution, and provide lower cost and more energy-efficient transportation.

B.J.

**A79-27657 Hydrogen - Potential key to tomorrow's energy utility.** R. M. Lundberg (Commonwealth Edison Co., Chicago, Ill.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.

Flushing, N.Y., Scholium International, Inc., 1978, p. 105-110. 15 refs.

There are premium uses for fuels in the electric utility for which hydrogen seems appropriate. The cost of electrolytic conversion is marginal, but suitable for some utilities. The costs of storage may be the major obstacle to commercial scale development. There are adequate incentives and potentially a very large market to interest all utilities in the production of hydrogen for sale. Hardware for the large-scale combustion of hydrogen requires a moderate amount of development. Breaking into the field at a small scale, providing hydrogen for generator cooling and ignitor fuel, provides a flexible near-term strategy. The utilities have investigated many methods to supplant natural gas and recently have been looking at hydrogen as a fuel for such use either directly or by adding the hydrogen to the natural gas pipeline as a tradeoff. The fuel cell technology may become a superior option for peaking use by the gas-electric utility.

G.R.

**A79-27659 Open-cycle MHD development.** D. H. Bomkamp (Argonne National Laboratory, Argonne, Ill.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.

Flushing, N.Y., Scholium International, Inc., 1978, p. 135-144.

The purpose of the federally-funded Energy Conversion Alternatives Study was to identify alternative energy conversion concepts and to economically analyze these concepts. Ten types of advanced power plant concepts were analyzed in terms of overall energy efficiency from coal pile to bus bar and in terms of the cost of electricity. Of the concepts which were studied, open-cycle MHD (MHD topping cycle/steam bottoming plant) showed the highest overall system efficiency and had one of the lowest costs of electricity at 32 mills per kilowatt hour. A comparison between a steam and an MHD power plant is shown. The significant feature is that the large rotating machinery of a steam plant is replaced by an MHD generator. Since typical temperatures for MHD are higher, energy can be extracted more efficiently.

G.R.

**A79-27660 An overview of liquid metal MHD.** P. F. Dunn (Argonne National Laboratory, Argonne, Ill.). In: Applications of

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cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.

Flushing, N.Y., Scholium International, Inc., 1978, p. 145-158. Research sponsored by the U.S. Department of Energy and U.S. Navy.

Since high temperatures are not needed to provide adequate electrical conductivity, liquid-metal MHD (LMMHD) power generators operate in a relatively low temperature range (450-1600 K) and can be coupled to almost any heat source. The present paper describes the basic LMMHD cycle and gives details of other cycles, including LMFB/R/LMMHD Rankine and open-cycle, coal-fired LMMHD. Efficiency comparisons are given for the various cycles and a schematic of a high-temperature Na-N<sub>2</sub> LMMHD facility is presented. B.J.

**A79-27661 # Status of the U.S./U.S.S.R. cooperative program for the development of open-cycle MHD power generators.** K. E. Tempelmeyer (Argonne National Laboratory, Argonne, Ill.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978. Flushing, N.Y., Scholium International, Inc., 1978, p. 159-172. Contract No. W-31-109-eng-38.

The cooperative program has been channeled into four major directions: (1) preparation of a joint status report on open-cycle MHD power generation; (2) joint materials tests in facilities in both countries; (3) joint tests in the Soviet U-25B facility with a U.S. superconducting magnet and a Soviet MHD generator; and (4) the design and testing of a large U.S.-built MHD generator to be tested in the U-25 facility. Working groups were organized in the U.S. to address the major problems in channel design and testing, electrode system development, and superconducting MHD magnetic development. Another working group was organized to prepare a status report covering all aspects of MHD. B.J.

**A79-27662 Superconducting magnet systems for MHD generator facilities.** R. C. Niemann (Argonne National Laboratory, Argonne, Ill.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978. Flushing, N.Y., Scholium International, Inc., 1978, p. 173-194. 11 refs. Research supported by the U.S. Department of Energy.

The paper reviews superconducting magnet system design requirements and existing and planned superconducting magnet systems for MHD generators. It is concluded that the successful development and implementation of MHD systems for commercial power generation facilities is strongly dependent on the existence of reliable and economical large high-field superconducting magnet systems. The development of such magnet systems will require the utilization of a continuously advancing cryogenic technological base coupled with extensive contributions from various elements of the entire cryogenics industry. B.J.

**A79-27663 High energy physics superconducting magnets and cryogenic systems.** C. H. Rode (Fermi National Accelerator Laboratory, Batavia, Ill.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.

Flushing, N.Y., Scholium International, Inc., 1978, p. 197-212. 6 refs.

A brief historical review of pool boiling systems is presented. This is followed by a description of three large superconducting magnet facilities: (1) ESCAR (Experimental Superconducting Accelerator Ring) at Lawrence Berkeley Laboratory, (2) ISABELLE (Intersecting Storage and Accelerator) at Brookhaven National Laboratory, and (3) TEVATRON (TeV Accelerator and Storage Ring) at Fermi National Accelerator Laboratory. B.J.

**A79-27666 Air Force applications of lightweight superconducting machinery.** C. E. Oberly (USAF, Aero Propulsion

Laboratory, Wright-Patterson AFB, Ohio). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.

Flushing, N.Y., Scholium International, Inc., 1978, p. 293-334. 45 refs.

Consideration is given to the dominant factors which affect the development of such Air Force airborne superconducting machinery as alternators, MHD magnets, and energy storage devices. These factors include lightweight structure design and severe losses induced by transient fields and conductor motion. Adequate structure, stabilizing matrix and cooling are difficult to design because of weight and volume restrictions. The promise of greater thermal margin in advanced superconducting materials such as flexible multifilament Nb<sub>3</sub>Sn and the weight saving potential of advanced structural materials provides impetus for continued Air Force development programs. B.J.

**A79-27667 Doublet III.** E. L. Hubbard (General Atomic Co., Fusion Div., San Diego, Calif.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.

Flushing, N.Y., Scholium International, Inc., 1978, p. 337-353. 6 refs. Contract No. EY-76-C-03-0167.

An overview is presented of the Doublet III tokamak. Consideration is given to the doublet configuration, and to the construction, power systems, and test operation of the tokamak. The use of superconductors in future machines is briefly considered. B.J.

**A79-27668 The Alcator liquid nitrogen-cooled tokamaks.** D. B. Montgomery and N. T. Pierce (MIT, Cambridge, Mass.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978. Flushing, N.Y., Scholium International, Inc., 1978, p. 354-366. 5 refs. Research sponsored by the U.S. Department of Energy.

Alcator A and C are discussed with reference to conductor selection, cool-down, recool, and the nitrogen cooling system. Both devices use large quantities of liquid nitrogen for precooling the magnetic field systems, reducing the ohmic power required by a factor of 4 to 7 depending on the temperature rise in the particular magnetic system. The Alcator A device, with a total weight of 9 tons, uses about 800 gallons of liquid nitrogen to cool down from room temperature; it has been cooled down 250 times. The Alcator C device, with a weight of 40 tons, is expected to use about 2400 gallons for cool-down and 60 gallons per pulse for recool. B.J.

**A79-27669 Status report on TFTR.** P. J. Reardon (Princeton University, Princeton, N.J.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.

Flushing, N.Y., Scholium International, Inc., 1978, p. 367-387.

The primary objectives of the Toroidal Fusion Test Reactor (TFTR) are the generation and confinement of 5-10 keV reactor-grade plasmas in a tokamak magnetic field configuration and the production of fusion energy on a pulsed basis. The TFTR will be used to study the physics of burning plasmas and the engineering aspects of a D-T burning tokamak operating with reactor-level plasma conditions. The present paper reviews the TFTR program with consideration given to primary functions, design requirements, and major engineering features. B.J.

**A79-27723 The Tritherm test house (Das Tritherm-Versuchshaus).** D. Deutschnmann (Robert Bosch GmbH, Zentralabteilung Bauten und Anlagen, Stuttgart, West Germany), A. Kehl, W. Kragl, and F. Scharf (Robert Bosch GmbH, Technisches Zentrum Forschung, Stuttgart, West Germany). *Bosch Technische Berichte*, vol. 6, no. 4, 1979, p. 195-208. 6 refs. In German.

The present paper deals with 'Tritherm' solar house designed by Junkers. The heating system of this test house uses solar radiation and the ambient atmosphere for space and water heating, partly

directly and partly indirectly by means of a heat pump. Peak loads are covered by a gas-fired supplementary heating system. Test results to-date indicate climate fuel consumption can be held as low as 10 percent of the initial consumption. The cost effectiveness of such installations, however, appear to be questionable. V.P.

**A79-27733** Toxic component concentration in kerosene-air mixture combustion products. V. N. Gruzdev. (*Aviatsionnaya Tekhnika*, vol. 21, no. 1, 1978, p. 49-52.) *Soviet Aeronautics*, vol. 21, no. 1, 1978, p. 36-38. Translation.

In the present paper, the contents of NO, NO<sub>2</sub>, and CO in the combustion products of kerosene-air mixtures are determined from thermodynamic calculations of combustion, involving the solution of a system of algebraic equations comprising a dissociation equation, the Dalton law, the balance of matter, and the conservation of heat content. The results are obtained for mixture temperatures ranging from 473 to 973 K and excess air ratios between 0.5 and 15.0. V.P.

**A79-27871** An investigation of dark current and photocurrent superposition in photovoltaic devices. N. G. Tarr and D. L. Pulfrey (British Columbia, University, Vancouver, Canada). *Solid-State Electronics*, vol. 22, Mar. 1979, p. 265-270. 8 refs. Research supported by the National Research Council of Canada.

The principle of superposition of light and dark currents states that the current flowing in an illuminated photovoltaic device subject to a bias V is given by the superposition of the short-circuit photo-current and the current that would flow at bias V in the dark. In this paper, a simple theoretical argument based on Shockley's (1949) analysis of the pn junction diode is presented to demonstrate that the superposition principle is valid for practical Si and GaAs homojunction photovoltaic devices subject to one sun illumination and biased close to the maximum power point. Computer simulation confirms that superposition can be a useful approximation even when recombination and photogeneration in the depletion region contribute significantly to the dark current and photocurrent, respectively. Computer simulation also shows that under one sun illumination and short-circuit conditions the quasi-Fermi levels in the depletion regions of typical Si and GaAs solar cells are shifted substantially from their equilibrium positions. S.D.

**A79-27876** Macroscopic stability and beta limit in the ELMO Bumpy Torus. D. B. Nelson and C. L. Hedrick (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 283-292. 7 refs. Research sponsored by the U.S. Department of Energy.

Magnetohydrodynamic stability limits are determined for the ELMO Bumpy Torus. The relativistic hot-electron annuli are considered to be rigid, modifying the magnetic field but not interacting with the instability. A modified energy principle is used, and the stability problem is reduced to determination of the eigenvalues of an ordinary differential equation along each field line. A threshold hot-electron current is required for stability; its value agrees with experimental measurements. The calculations show that stable high-beta equilibria can be created. Experiments are being planned to test these predictions. (Author)

**A79-27877** Recombination-induced neutral-particle flux, in tokamaks. Iu. N. Dnestrovskii, S. E. Lysenko (Akademiiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR), and A. I. Kisliakov (Akademiiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 293-299. 14 refs. Translation.

On the Alcator device the main mechanism producing neutrals in the central region of the plasma at a density in excess of  $4 \times 10^{10}$  to the 14th per cu cm is recombination of protons and electrons. The calculated neutral fluxes and spectra agree with the measured values. A suitable method of determining the ion temperature from the tail of the fast-neutral spectra for a dense plasma is described. (Author)

**A79-27878** Pellet X-ray spectra for laser fusion reactor designs. G. R. Magelssen and G. A. Moses (Wisconsin, University, Madison, Wis.). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 301-311. 9 refs. Research supported by the Electric Power Research Institute.

The calculated X-ray energy contents, spectra and pulse lengths for a range of simple target designs that include deuterium-tritium fuel surrounded by mercury are given. The calculations start with a compressed pellet core at the time of ignition and the evolution of the burning pellet is followed by using a plasma hydrodynamic-thermonuclear burn-radiative transfer computer code. It is shown that the pellet-released radiation energy contents, spectra and pulse lengths depend upon pellet mass, density and material structure, and total yield. (Author)

**A79-27879** Self-consistent analysis of alpha-particle heating of a fast-solenoid plasma. H. J. Willenberg (Washington, University, Seattle, Wash.). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 313-326. 28 refs. NSF-ERDA-sponsored research.

A method is formulated to describe the development of the alpha particles produced by fusion in a slender cylindrical plasma column that includes a fusion source and nonuniform thermalization. A numerical technique is presented which makes it possible to determine in a fully self-consistent manner the alpha-particle and background-plasma behavior in the case where the alpha particles transfer energy to the plasma electrons and ions in a nonuniform manner during thermalization, and the plasma is heated and expands. This technique is applied to the particular case of a fast laser-heated solenoid plasma; a parametric study of alpha heating of plasmas with a variety of initial temperatures, radii, and plasma betas is also performed. It is shown that a plasma column with a radius of 7 mm, a temperature of 6 keV, and a beta value of 0.95 will attain an ion temperature of 10 keV (corresponding to a fusion energy gain of 8) after 3 ms and that a range of maximum gain occurs for initial temperatures of 5 to 7 keV. Consequences of anomalously high alpha-particle energy transfer and plasma transport coefficients are investigated. F.G.M.

**A79-27880** On the motion of runaway electrons in momentum space. G. Fussmann (EURATOM and Max-Planck-Institut für Plasmaphysik, Garching, West Germany). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 327-334. 7 refs.

The suprathermal drag force and the motion of suprathermal electrons in momentum space are analyzed for a multi-component plasma. The calculations of the particle motion are based on the suprathermal Fokker-Planck equation and include relativistic effects. It is found that, owing to pitch angle scattering, the flow patterns in momentum space are more complicated than previously assumed. Simple expressions for the runaway threshold and the perpendicular momentum of relativistic runaways are derived. The acceleration and slowing-down of runaways are also briefly discussed. (Author)

**A79-27881** The effect of limiters and current profile on elliptic free-boundary MHD equilibria. C. L. Thomas and F. A. Haas (EURATOM and U.K. Atomic Energy Authority Fusion Association, Culham Laboratory, Abingdon, Oxon, England). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 335-346. 12 refs.

The MHD equilibrium equations and assumptions of simple current profiles and various limiter configurations are used to investigate the ellipticity attainable in a straight magnetic quadrupole field. It is found that for certain prescriptions of parameters there are two values of ellipticity b/a. In practice, only the lower value is expected to be realizable; its maximum value depends on current profile and choice of limiter and, for the models used here, lies between 1.0 and 2.9. For the prescriptions that lead to a single ellipticity, the upper limit to b/a is set by the intervention of the separatrix, and for the present models a value of approximately 2.0 has been obtained. (Author)

**A79-27882** Stabilization of drift loss-cone instability /DCI/ by addition of cold ions. B. I. Kanaev (Akademiiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 347-359. 18 refs. Translation.

## A79-27884

It is demonstrated experimentally that in the containment of a collisional hydrogen plasma in a PR-6 mirror trap, which is accompanied by strong instability, a quiescent phase occurs as a result of the inflow of cold plasma remaining after the injection is turned off. With the use of the technique of cutting off the inflow it has been shown clearly that the instability begins to develop when the inflow drops to a fairly low value. It is also shown that in earlier experiments on microwave stabilization of an instability the same inflow brought about the cold-ion filling of the potential well that was formed. By the use of the cut-off it became possible to create an empty well and to fill it with cold ions of a selected gas in a controlled manner. It was found that during filling of the well with hydrogen ions, suppression of the instability apparently takes place at values of cold-ion addition which are substantially lower than 5% of the hot-plasma density. A similar addition of argon ions has no stabilizing effect. (Author)

**A79-27884** Theory of dissipative drift instabilities in sheared magnetic fields. L. Chen, P. N. Guzdar, J. Y. Hsu, P. K. Kaw, C. Oberman, and R. White (Princeton University, Princeton, N.J.). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 373-387. 25 refs. Contracts No. EY-76-C-02-3073; No. F44620-75-C-0037.

Several different techniques are used to study the stability of electrostatic drift-wave eigenmodes in a resistive plasma with finite magnetic shear. It is found that in the slab approximation, where usual shear damping is operative, resistivity contributes to an enhancement of this damping, and the enhancement factor increases with the electron-ion collision frequency. Thus, no unstable eigenmodes result. If the shear damping is nullified, either by introducing a strong spatial variation of the density gradient or by working in toroidal geometry with strong toroidal coupling effects, then unstable eigenmodes with growth rates increasing with electron-ion collision frequency are recovered. A perturbation calculation shows that the retention of electron-temperature fluctuations associated with the mode and the inclusion of temperature gradients do not alter these conclusions. Extensive numerical calculations are also presented. (Author)

**A79-27885** Characteristics of electron-cyclotron-resonance-heated tokamak power reactors. S. M. Wolfe, D. R. Cohn, R. J. Temkin, and K. Kreischer (MIT, Cambridge, Mass.). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 389-399. 22 refs. NSF-supported research; Contract No. EG-77-S-02-4183.

The characteristics of electron-cyclotron resonance-heated tokamak reactors are determined, based on the requirements for wave propagation and absorption in the plasma. Heating at both the fundamental and the second harmonic is considered, and constraints on the toroidal beta and the minimum magnetic field required to obtain suitable fusion power densities are derived. The magnetic field and temperature necessary to achieve ignition are calculated on the basis of the empirical scaling law for energy confinement time. Frequency requirements are determined, and frequencies of the order of 200 GHz are shown to be attractive for heating tokamak reactors of moderate size and thermal power levels. It is concluded that the development of HF (at least 200 GHz) gyrotron sources will probably be necessary in order to use electron-cyclotron resonance heating in tokamak power reactors. F.G.M.

**A79-27886** The effect of thermo-electric forces on the density profiles in a thermonuclear plasma surrounded by a cold blanket. J. A. Markvoort (EURATOM and Stichting voor Fundamenteel Onderzoek der Materie, Instituut voor Plasma-Fysica, Jutphaas, Netherlands). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 401-407. 23 refs. Research supported by the Nederlandse Organisatie voor Zuivere Wetenschappelijk Onderzoek and EURATOM.

**A79-27887** Evidence for neutral-beam-injected oxygen impurities in 2XIIIB. R. P. Drake and H. W. Moos (Johns Hopkins University, Baltimore, Md.). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 407-410. 11 refs. Contracts No. EY-76-S-02-2711; No. W-7405-eng-48.

A series of experiments indicates that the principle source of impurities in the 2XIIIB mirror confinement plasma experiment at Lawrence Livermore Laboratory is oxygen in the neutral beams. The dependence of O II 539 Å emissions on neutral-beam current, spatial scans of oxygen emissions, impurity injection experiments, spectral scans of the O VI 1032 Å line, and other experiments all support this conclusion. (Author)

**A79-27897** # Transport fuels from natural gas. B. V. Walker. *New Zealand Energy Journal*, vol. 51, Dec. 25, 1978, p. 194-196.

A solution to the energy problem with transport fuels in New Zealand is proposed through options based on natural gas. The advantages of natural gas are cited, noting, that the technology for converting it for transport use is comparatively low in capital cost, high on reliability, and environmentally clean. A 15% methanol/gasoline blend is suggested for short-term options, and an examination of possible technical problems associated with the blend is presented, concluding that methanol/gasoline blends are good automotive fuels, and present no significant corrosion problems. Long-term options are analyzed, with methanol and synthetic gasoline as choices, showing that they are competitive and contrasting alternatives, methanol being economically more attractive, while synthetic gasoline displays no downstream problems. A.A.

**A79-27898** # Electricity - An indigenous transport fuel. D. J. Byers (Canterbury University, Christchurch, New Zealand). *New Zealand Energy Journal*, vol. 51, Dec. 25, 1978, p. 197-200. Research supported by the University of Canterbury, New Zealand University Grants Committee, and New Zealand Lottery Distribution Committee for Scientific Research.

The electric car, as a viable alternative to the gasoline-fuelled vehicle, is examined in the context of New Zealand's energy-consumption and transport-energy-requirements scenario. Estimates of oil and gasoline energy usage in transport for 1977 are considered, indicating that gasoline fuelled vehicles consume the most significant port of all of New Zealand's oil imports, thus making them the most vulnerable to challenge by the electric vehicle. A comparison of the operation of gasoline and battery-electric vehicles is made, based on official figures for 1977, and it is shown that a shift to electric vehicles could be made without overloading electricity generation capacity. Proposals for developing experimental electric cars, trucks, and other vehicles are considered, noting, that the Electric and Hybrid Vehicle Act calls for the U.S. Government to fund up to 5000 advanced experimental vehicles for evaluation in 1981. Battery systems using aqueous acids, alkalines, or molten salt are considered and it is indicated that many battery types already seem to meet the requirements for various types of vehicles. A.A.

**A79-27899** Economic feasibility of solar water and space heating. R. H. Bezdek (U.S. Department of Energy, Washington, D.C.), A. S. Hirshberg, and W. H. Babcock (Booz, Allen, and Hamilton, Inc., Bethesda, Md.). *Science*, vol. 203, Mar. 23, 1979, p. 1214-1220. 12 refs.

The economic feasibility in 1977 and 1978 of solar water and combined water and space heating is analyzed for single-family detached residences and multifamily apartment buildings in four representative U.S. cities: Boston, Massachusetts; Washington, D.C.; Grand Junction, Colorado; and Los Angeles, California. Three economic decision criteria are utilized: payback period, years to recovery of down payment, and years to net positive cash flow. The cost competitiveness of the solar systems compared to heating systems based on electricity, fuel oil, and natural gas is then discussed for each city, and the impact of the federal tax credit for solar energy systems is assessed. It is found that even without federal incentives some solar water and space heating systems are competitive. Enactment of the solar tax credit, however, greatly enhances their competitiveness. The implications of these findings for government tax and energy pricing policies are discussed. (Author)

**A79-28028** Optical coatings for a space laser communications system. R. M. F. Linford (McDonnell Douglas Astronautics Co.,

St. Louis, Mo.) and E. A. Strouse (Perkin-Elmer Corp., Norwalk, Conn.). In: *Laser and fiber optics communications; Proceedings of the Seminar, San Diego, Calif., August 28, 29, 1978.*

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 55-66.

A study has been conducted to develop and evaluate the optical coatings required for a space laser communications system. The requirements for the Nd:YAG laser, solar collector optics, and other optical components are discussed. The approach to the design, fabrication, and evaluation of the coatings is outlined, including the environmental tests planned to determine the stability of the coatings in space. Selected experimental results are included. (Author)

**A79-28140** *Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.* Seminar sponsored by the Society of Photo-Optical Instrumentation Engineers. Edited by K. D. Masterson. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Volume 161), 1978. 122 p. \$36.

Papers deal with concentrating collectors, materials for solar photothermal converters, and measurements of insolation. Particular consideration is given to a comparison of solar thermal energy collection using fixed and tracking collectors, microstructural characterization of a black chrome solar selective absorber, and inclination dependence of pyranometer sensitivity. B.J.

**A79-28141** *First-order design variables for concentrating solar collectors.* J. F. Kreider (J. F. Kreider Associates, Boulder, Colo.). In: *Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.*

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 2-11. 5 refs.

The three major design variables of solar concentrators - optical efficiency, heat loss coefficient, and heat removal factor - are described. Equations are presented for estimating these design variables; typical values are: optical efficiency in the range 50-70%, heat loss coefficient of 1.0-1 W/sq m deg C, and heat removal factors exceeding 0.95. B.J.

**A79-28142** *System designs for low cost-low ratio solar concentrators.* T. M. Knasel (Science Applications, Inc., McLean, Va.). In: *Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.*

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 14-22. 6 refs.

Low-cost, low-ratio solar concentrators can be approached from a number of design principles. A fixed imaging system would have concentration highly dependent on the off-axis angle, and the moving solar image does not appear to be incompatible with the conditions. Nonimaging devices are available in low-cost, low-ratio design versions; the concentration is inversely proportional to the angular acceptance while the system length and diffuse acceptance are proportional to the angular acceptance. Booster systems can achieve up to a factor of 3 concentration on two-sided receivers with uniform illumination and appear to be relatively inexpensive. Light trapping techniques appear to satisfy all the design criteria and would be best employed with very costly receiver materials such as solar cells. B.J.

**A79-28143** *Linear echelon refractor/reflector solar concentrators.* D. F. Vanderwerf, R. H. Anderson, and R. H. Appeldorn (3M Co., St. Paul, Minn.). In: *Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.*

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 23-28. 9 refs.

This paper describes some new configurations for linear incremental or Fresnel refractors and reflectors for solar energy concentration. The first system, a reflex type lens, uses crossed linear echelon elements and has convergence power in two dimensions. This refractor/reflector concentrates solar radiation to a spot focus. Large

area solar concentrators can be sectionally constructed to provide high power solar flux concentration. The second type of echelon reflector forms a linear focus of incident solar radiation. The reflector is selectively tilted with respect to incoming solar radiation, such that the design eliminates all riser step blockage of radiation at the reflecting echelons. This results in a higher efficiency concentrator than is achievable with a normally oriented linear focus concentrator. Design parameters and a ray trace analysis are presented for both concentrator systems. (Author)

**A79-28144** *A flat plate multiple pass solar collector using aqueous optical properties.* W. D. Antrim, Jr., M. J. Pitasi, and R. W. Miller (American Science and Engineering, Inc., Cambridge, Mass.). In: *Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.*

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 29-35. 8 refs.

A flat plate multiple pass solar collector is described which bridges the gap between concentrators and conventional flat plate collectors. This novel collector performs optically by taking advantage of two fortuitous characteristics of plain water: high transparency to the optical spectrum and near total opacity to the infrared. As solar energy heats the water, the potential radiative escape of this energy is via the infrared. A simple multiple pass system impacts the solar energy sequentially as it is blocked by opacity of the water in the earlier passages. The design is such that it minimizes air convection losses by virtue of the layers of the multipass system. B.J.

**A79-28145** *A parabolic solar reflector for accurate and economic producibility.* W. D. Antrim, Jr., R. W. Miller, and M. J. Pitasi (American Science and Engineering, Inc., Cambridge, Mass.). In: *Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.*

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 36-45. Contract No. EM-78-C-04-4275.

This paper focuses on the reflector portion of a solar collector, being developed for solar heating and cooling applications. Work to date on the second generation concentrating collector includes design and development of low-cost reflectors and breadboard testing of simplified tracking schemes. The concentrating parabolic reflector described herein is designed to maintain accurate geometry for good optical performance. This is accomplished by a construction which would also be low-cost in production quantities. The receiver is integral with the concentrating reflector and is functional in maintaining geometric tolerances; in addition, the receiver is designed for minimum heat loss and low cost. B.J.

**A79-28146** *A comparison of solar thermal energy collection using fixed and tracking collectors.* J. D. Garrison, G. T. Craig, and C. Morgan (San Diego State University, San Diego, Calif.). In: *Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.*

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 46-54. 10 refs. Research supported by the San Diego State University.

Solar thermal energy collection at seven sites (Albuquerque, New Mexico; Ft. Hood, Texas; Highett, Australia; Livermore, California; Maynard, Massachusetts; Raleigh, North Carolina; and San Diego, California) is calculated for air and vacuum flat plate collectors and a vacuum collector using cylindrical Winston collection. The hourly intensity and angular distribution of solar radiation is predicted for the calculations using insolation measurements and an insolation wheel. Tracking configurations include two-axis, vertical axis, polar axis, and east-west axis tracking. Fixed collector arrays are all tilted towards the equator at the latitude angle. These calculations indicate energy collection varies linearly with cloudiness index. B.J.

**A79-28147** *Analysis of a Cassegrain solar furnace.* M. H. Cobble, W. C. Hull, and R. A. Hays (New Mexico State University, Las Cruces, N. Mex.). In: *Optics applied to solar energy IV; Proceed-*

## A79-28148

ings of the Seminar, San Diego, Calif., August 30, 31, 1978. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 55-63.

A solar furnace consisting of a paraboloid of revolution which tracks the sun and reflects radiation to a hyperboloid of revolution having a common focus with the paraboloid is analyzed to determine the concentration available, using various eccentricities. The hyperboloid, in turn, reflects radiation to a focal plane placed at various distances from the vertex of the paraboloid. The ideal concentration is determined using the largest radius of all the rays from the sun falling on the paraboloid, this radius being the distance from the pierce point of the ray, in the focal plane, to the hyperboloid focal point. The concentrations can be augmented using a compound paraboloidal concentrator, and the ideal augmented concentration is developed for various combinations of eccentricity and vertex distances. The effect of scattering angles for the paraboloid and hyperboloid on the ideal concentration is shown separately and jointly.

(Author)

**A79-28148** Chemical vapor deposited molybdenum films for use in photothermal conversion. G. E. Carver, D. D. Allred, and B. O. Seraphin (Arizona, University, Tucson, Ariz.). In: Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 66-71. 13 refs. Contracts No. ER-78-S-02-4899; No. EY-76-S-04-3709.

High IR reflectance combined with high solar absorptance is required for efficient photothermal conversion. Converters can be fabricated by depositing an absorber on a highly reflecting metal. The present paper shows that, unlike other deposition methods, chemical vapor deposition (CVD) can produce molybdenum films with an IR reflectance rivaling that of bulk molybdenum. Studies are being performed to determine how sensitively the reflectance reacts to inclusions of impurities into the molybdenum. Thin film passivators deposited on the molybdenum prevent reflectance losses induced by oxidation and ensure high-temperature survival of optimal reflectance. Complete converter stacks have been annealed at 550 C for over 1000 hours in air.

B.J.

**A79-28149** Chemical vapor deposited amorphous silicon for use in photothermal conversion. D. C. Booth, M. Janai, G. Weiser, D. D. Allred, and B. O. Seraphin (Arizona, University, Tucson, Ariz.). In: Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 72-75. 7 refs. Contract No. ER-78-S-02-4899.

Efficient photothermal conversion requires surfaces of high solar absorptance and low thermal emittance. This can be accomplished by the tandem action of a good infrared reflector overlaid by a film of sufficient solar absorptance that is transparent in the infrared. Crystalline silicon is a suitable candidate for the absorber layer. Its indirect band gap, however, results in a shallow absorption edge that extends too far into the visible. In contrast, the absorption edge of amorphous silicon is steeper and located farther into the infrared, resulting in a larger solar absorptance. The paper reports on the fabrication of amorphous silicon absorbers by chemical vapor deposition (CVD). Their optical and structural properties are determined as a function of the deposition temperature. The effects of a progressive crystallization during anneal above 650 C are described and the performance of converter stacks that are identical 'twins' except for the use of a polycrystalline silicon absorber in one and an amorphous absorber in the other are reported.

(Author)

**A79-28150** Colored stainless steel - A new type of selective absorber. B. Karlsson (Arizona, University, Tucson, Ariz.) and C. G. Ribbing (Uppsala Universitet, Uppsala, Sweden). In: Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 76-83. 10 refs. NSF Grant No. INT-76-02664.

Selective absorbers for solar photothermal conversion are required to have high absorptance or low reflectance over the spectral range of solar emission and low emittance or high reflectance in the IR region. The paper reports on reflectance measurements on a type 304 stainless steel which provides a reasonable approximation to the ideal selective surface. The desired selectivity was obtained by oxidation of the steel in an acid solution. The steel deteriorates at temperatures above 200 C; the deterioration mechanisms are dehydration and oxidation. It is suggested that the colored steel should be stabilized at higher temperatures by coating it with a thin film such as Cr<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, or Si<sub>3</sub>N<sub>4</sub>.

B.J.

**A79-28151** Microstructural characterization of a black chrome solar selective absorber. C. M. Lampert (California, University, Berkeley, Calif.). In: Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 84-90. 10 refs. Research supported by the U.S. Department of Energy.

The microstructure and reflective properties of the CHROMONYX type of black chrome/metal selective absorber coating for solar collectors were investigated in order to gain an understanding of the effect of these factors on the mechanism of wavelength selectivity. Hemispherical reflectance measurements were carried out on seven samples. The coatings which exhibited the best sensitivity were 1.0-micron black chrome plated on copper and 0.7-micron black chrome on nickel-plated copper and steel. Electron microscopy showed that the black chrome consisted of a distribution of very fine chromium particles (in the 100-A range) suspended within a matrix of chromium oxide phase. This assembly was then agglomerated into larger particles within the 0.05-0.3 micron range; these larger particles formed a continuous network which constituted the coating.

B.J.

**A79-28152** New instrumentation for high temperature and hemispherical measurements of selective surfaces. M. R. Jacobson, R. D. Lamoreaux, R. P. Shimshock, N. Raouf, and B. O. Seraphin (Arizona, University, Tucson, Ariz.). In: Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 92-97. 7 refs. Contracts No. ER-78-S-02-4899; No. EY-75-S-04-3709; No. F49620-77-C-0138.

The Measurement Laboratory at the University of Arizona's Sciences Center has been performing studies on the optical properties and durability of solar selective surface under simulated operating conditions. Recent developments include: (1) a transmission cell for the high temperature reflectometer is being designed to measure samples at high temperature (800 C) under vacuum or controlled atmospheres; (2) a new data processing system has been interfaced with the existing integrating sphere reflectometer; (3) a cylindrical vacuum emissometer for the measurement of the total hemispherical radiative power loss from a heated sample is under consideration; and (4) a Gaertner L119 ellipsometer is being extended into the near-IR to provide measurements of optical constants of absorber materials through the solar spectrum.

B.J.

**A79-28153** Specularity measurements for solar materials. M. A. Lind, J. S. Hartman, and H. L. Hampton (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 98-105. 7 refs. Contract No. EY-76-C-06-1830.

A technique using Fourier transform analysis which is suitable for measuring the specularity of solar glass components in the mrad and sub-mrad is discussed and demonstrated. A brief mathematical background as well as illustrative examples are included. A number of methods for image analysis are discussed with particular emphasis given to electronic integrating detectors. Typical Fourier plane image distributions are given for a few common solar utilization materials

and details of the instrument used to produce the images are considered. The limitations and capabilities of various instruments are outlined along with methods for further enhancing the utility and sensitivity of the technique.

(Author)

**A79-28154 Inclination dependence of pyranometer sensitivity.** K. A. Reed (Argonne National Laboratory, Argonne, Ill.). In: *Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.* Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 106-108. Contract No. W-31-109-eng-38.

The inclination dependence of Eppley Model 8-48 pyranometers (initially acquired to support solar collector testing) has been measured in indoor tests conducted at levels of illumination corresponding to about 500 and 1000 W/sq m. The sensitivity is found to decrease as the pyranometer is tilted from the horizontal, the magnitude of the decrease depending on the level of illumination as well as the angle of inclination. Potentially large residual errors may limit the usefulness of such data; until the residual is quantified, it is difficult to justify the use of Model 8-48 pyranometers. B.J.

**A79-28182 Development of specifications for recycled products.** H. Alter (National Center for Resource Recovery, Inc., Washington, D.C.). *(World Recycling Congress, 1st, Basel, Switzerland, Mar. 6-9, 1978.) Conservation and Recycling*, vol. 2, no. 1, 1978, p. 71-84. 39 refs. U.S. Environmental Protection Agency Contract No. 68-03-2528.

The paper discusses certain aspects of the development of specifications for materials and fuels derived from the mechanical and/or chemical processing of mixed municipal wastes. Trends in the development of specifications for paper, steel, aluminum, glass, and refuse-derived fuels are studied, and tentative composition limits are presented. The status of various programs to develop tests to accompany specifications is discussed. P.T.H.

**A79-28183 Modern technology for recovering energy and materials from urban wastes - Its applicability in developing countries.** M. A. Connor (Stellenbosch, University, Stellenbosch, Republic of South Africa). *(World Recycling Congress, 1st, Basel, Switzerland, Mar. 6-9, 1978.) Conservation and Recycling*, vol. 2, no. 1, 1978, p. 85-93. 27 refs.

Three developing countries, Kenya, India and South Africa, very different as far as population density, degree of urbanization, extent of industrialization and availability of domestic energy resources are concerned, were selected for particular study. For each of these countries the energy supply, use and distribution patterns, as well as current refuse disposal practices are described. The future use of various refuse treatment methods, particularly those involving energy recovery, in each of these countries is examined. The conclusions drawn for the above three countries are generalized and applied to developing countries as a group. It is concluded that the applicability of modern refuse treatment technology in such countries is limited. (Author)

**A79-28315 Theory of the striated corona in a theta pinch.** N. A. Krall, J. B. McBride, and L. Matteson (Science Applications, Inc., La Jolla, Calif.). *Physics of Fluids*, vol. 22, Mar. 1979, p. 515-518. 7 refs. Research supported by the U.S. Department of Energy.

The radial striations observed in the low density corona surrounding a theta-pinch-confined plasma are explained as due to an instability at the ion plasma frequency driven by plasma rotation in the corona. A nonlocal theory is used to find radially extended modes, as observed experimentally. The observed wavelength of the striations can then be used to deduce the density in this region; this density is in reasonable agreement with estimates from numerical models. (Author)

**A79-28352 Solar thermal electrical power plants for Iran.** S. Vojdani and V. J. Woollam (Arya Mehr University of Technology, Teheran, Iran). *Solar Energy*, vol. 22, no. 3, 1979, p. 205-210.

**A79-28353 A Markov model of solar energy space and hot water heating systems.** G. F. Lameiro (Solar Energy Research Institute, Golden, Colo.) and W. S. Duff (Colorado State University, Fort Collins, Colo.). *Solar Energy*, vol. 22, no. 3, 1979, p. 211-219. 10 refs. Research supported by the Colorado State University and NSF.

This paper presents a Markov model approach to the generalized solar energy space heating performance analysis problem. Specifically, Markov chain models are developed to represent ambient temperature, insolation, hot water load and system performance. From the Markov transition probability matrices for these variables, long-term expected performance is calculated. The theoretical development is implemented in FORTRAN IV on a Control Data 6400 Computer System. Computational experience gained, using STOLAR 3.1 (STOchastic soLAR energy systems model), indicates the stochastic approach requires approximately five per cent of the time necessary for standard dynamic approaches with comparable performance results. The method also compared favorably with FCHART, a simplified design procedure. (Author)

**A79-28354 Thermal analysis of black liquid cylindrical parabolic collector.** B. J. Huang, T. Y. Wung, and S. Nieh (National Taiwan University, Taipei, Nationalist China). *Solar Energy*, vol. 22, no. 3, 1979, p. 221-224.

In the present paper a simple theoretical analysis and an experiment are carried out for a modified concentrating collector which consists of a cylindrical parabolic reflector, a transparent glass tube centered along the focal line, and a highly absorbent black liquid which flows in the glass tube to directly absorb the concentrated solar beam radiation. The analytical results are presented in normalized form and proved to be in very good agreement with the experimental results. (Author)

**A79-28356 Results and analysis of a round robin test program for liquid-heating flat-plate solar collectors.** E. R. Streed, J. E. Hill (National Bureau of Standards, National Engineering Laboratory, Washington, D.C.), W. C. Thomas, A. G. Dawson, III (Virginia Polytechnic Institute and State University, Blacksburg, Va.), and B. D. Wood (Arizona State University, Tempe, Ariz.). *Solar Energy*, vol. 22, no. 3, 1979, p. 235-249. 11 refs. Research supported by the U.S. Department of Energy and NBS.

**A79-28358 Solar absorption cooling feasibility.** D. S. Ward (Colorado State University, Fort Collins, Colo.). *Solar Energy*, vol. 22, no. 3, 1979, p. 259-268. 39 refs. Research supported by the U.S. Department of Energy and Solar Energy Research Institute.

The thermodynamic efficiency of solar absorption cooling is very nearly equivalent to that of an electrically driven vapor-compression system with a high seasonal coefficient of performance (of the order of 2.0). In addition, water/lithium bromide absorption units have a history of demonstrated technical feasibility, particularly when integrated with a complete solar heating and cooling system. Economically, solar absorption cooling is marginal, but improves considerably with income tax incentives. B.J.

**A79-28359 A general design method for closed-loop solar energy systems.** S. A. Klein and W. A. Beckman (Wisconsin, University, Madison, Wis.). *Solar Energy*, vol. 22, no. 3, 1979, p. 269-282. 20 refs. Contract No. E(11-1)-2588.

A general design method is presented for closed loop energy systems consisting of solar collectors, sensible energy storage and a closed-loop flow circuit in which thermal energy is supplied (through heat exchange) to a load above a specified minimum temperature. It is assumed that the energy supplied to the load is used at a constant thermal efficiency. Computer simulations were used to estimate the long-term thermal performance of these systems, and correlations between the system performance and the system design parameters, such as the collector characteristics, load size, climatic data, and the minimum useful temperature, are presented. (Author)

## A79-28360

**A79-28360 Optical analysis of solar facility heliostats.** E. A. Igel and R. L. Hughes (Sandia Laboratories, Albuquerque, N. Mex.). *Solar Energy*, vol. 22, no. 3, 1979, p. 283-295. 16 refs. Research supported by the U.S. Department of Energy.

Useful insights into significant operating parameters are gained by treating the mirror collector system of a central receiver solar power station as an optical system, no matter how large. A method has been developed for estimating the approximate size of the solar image cast by individual heliostats. As a consequence from the Coddington equations, a simple analysis of astigmatism has been developed. These predictive equations agree well with experiments performed with a spherical mirror over a range of angles of incidence exceeding 60 deg. Other than flat mirrors, several heliostat configurations were proposed and explored and were found amenable to the same analysis. All designs which attempt to superpose the reflected energy from several mirrors mounted and tracked together on the same frame are subject to the same simple rules. (Author)

**A79-28361 Direct solar transmittance for a clear sky.** R. King and R. O. Buckius (Illinois, University, Urbana, Ill.). *Solar Energy*, vol. 22, no. 3, 1979, p. 297-301. 23 refs. Research supported by the University of Illinois.

An attempt is made to develop a general and simple model of direct solar transmittance in terms of fundamental measurable quantities. The spectral transmittance of the direct solar beam is formulated as a function of measurable quantities. Spectral integrations are performed with various combinations of the fundamental parameters. Approximate analytical forms are developed and unknown constants are determined from the spectral integration and expressed in terms of these fundamental parameters. B.J.

**A79-28366 Two-dimensional monochromatic X-ray imaging of laser-produced plasmas.** D. B. van Hulsteyn, P. Lee, and K. B. Mitchell (California, University, Los Alamos, N. Mex.). *Optics Letters*, vol. 4, Apr. 1979, p. 126-128. 9 refs.

A slotted crystal spectrograph has been used to produce two-dimensional, spatially resolved, monochromatic images of laser-irradiated targets. The technique is described, and examples are presented for comparison with corresponding pinhole photographs. Resolution along and transverse to the dispersion are determined by the crystal rocking angle and geometry of the spectrograph, respectively. One important application of this technique would be to radiograph hot, compressed targets, since the slotted spectrograph behaves as a filtered rectangular pinhole. (Author)

**A79-28389 A model for coal fly ash filtration.** R. Dennis and H. A. Klemm (GCA Corp., Technology Div., Bedford, Mass.). *Air Pollution Control Association, Journal*, vol. 29, Mar. 1979, p. 230-234. 13 refs. U.S. Environmental Protection Agency Contract No. 68-02-1438, EPA Task 5; EPA Task 6; EPA Task 7.

A new mathematical model for predicting the performance of woven glass filters with coal fly ash is described. The data base for this development includes an extensive bench and pilot scale study, field data from prior studies of fly ash filtration with glass fabrics, past studies of fabric filter cleaning mechanisms and a literature survey. Trial model applications with utility boilers operating at Sunbury, PA and Nucla, CO indicate excellent agreement between theory and practice for penetration and resistance characteristics. The introduction and experimental confirmation of two physical relationships were instrumental in model design. The first describes how dust dislodges from a fabric and its subsequent impact upon resistance and penetration in a multichambered system. The second concept relates to the large fraction of ash that passes through temporarily or permanently unblocked pores such that particle penetrations are essentially size independent. Additionally, the quantitation of the cleaning action and energy with dust removal method is included in the model. The calculation of dust specific resistance coefficient, based on size distribution parameters provides improved estimates of  $K_2$  in lieu of its preferred direct measurement. (Author)

**A79-28390 Electrostatic precipitation tests with fuel oil ash.** G. Dinelli, C. Borgatti (Ente Nazionale per l'Energia Elettrica, Pisa, Italy), and M. Rea (Padova, Università, Padua, Italy). *Air Pollution Control Association, Journal*, vol. 29, Mar. 1979, p. 242-248. 9 refs.

The main characteristics of the electrostatic collection of fuel oil ash has been investigated at a pilot precipitator installed in a laboratory rig. The relationship between collection efficiency, dust concentration and air velocity is studied and the influence of the spacing between the collection plates on both efficiency and effective migration velocity is discussed. Emphasis is put on the high degrees of efficiency attainable under suitable operating conditions. (Author)

**A79-28438 Lignite - Abundant raw material of the future (Le lignite - Matière première abondante d'avenir).** P. Speich. *Revue de l'Energie*, vol. 30, Feb. 1979, p. 103-109. 9 refs. In French.

This is the last of a series of articles devoted to the use of lignite in the Federal Republic of Germany. It deals with research and development activities and a calendar of research and development projects. The biggest deposit of lignite, with reserves of 55 billion tons, is located in the Rhineland. The technical projects elaborated over the past decades call for the exploitation of the major part of this deposit, that is about 35 billion tons of lignite. The reserves correspond to about the same energy reserves as all of Iran's oil deposits. It is one of the 'isolated energy' raw material deposits in the world. (Author)

**A79-28439 On future carburants. II (A propos des carburants du futur. II).** M. Grenon. *Revue de l'Energie*, vol. 30, Feb. 1979, p. 118-124. In French.

As was noted in the first part of this article, there is widespread incertitude concerning both possible future conception levels and future fuel needs over the next few decades. Although research on substitute fuels is not being carried-out with great vigor, methanol, ethanol and hydrogen must be mentioned as being the most promising solutions, or at least the solutions which are being most actively studied. This article deals with these fuels of the 'future'. (Author)

**A79-28666 # Study of photoelectric characteristics of photocells made from high-resistivity silicon (Issledovanie fotoelektricheskikh kharakteristik fotopreobrazovatelei iz kremlinia s vysokim udelynym soprotivleniem).** N. M. Bordina, T. M. Golovner, G. M. Grigor'eva, K. N. Zviagina, L. B. Kreinin, and N. A. Milovanova (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). *Geliotekhnika*, no. 6, 1978, p. 3-11. 7 refs. In Russian.

**A79-28667 # Effect of form errors on the characteristics of ellipsoidal radiant energy concentrators (Vliyanie pogreshnostei formy na kharakteristiki ellipsoidnykh kontsentratorov luchistoi energii).** L. Ia. Paderin. *Geliotekhnika*, no. 6, 1978, p. 12-15. In Russian.

**A79-28668 # Accelerated tests for coatings (K voprosu ob uskorennykh ispytaniakh pokrytiy).** R. A. Zakhidov (Akademii Nauk Uzbekskoi SSR, Tsentral'noe Proektno-Konstruktorskoe Biuro Nauchnogo Priborostroeniia, Uzbek SSR). *Geliotekhnika*, no. 6, 1978, p. 16-22. 11 refs. In Russian.

The application of an accelerated test method based on the so-called physical principle of reliability to accelerated life testing of the coatings for solar concentrators is considered. Considerable simplification of the method is achieved by assuming a linear form for the function relating the service life of the object to its operating regime. P.T.H.

**A79-28669 # Controlling the radiant flux of a high-temperature solar energy conversion system over two parameters**

(Regulirovanie luchistogo potoka vysokotemperaturnoi geloustovki po dvum parametram). V. V. Afian and A. V. Vartanian. *Geliotekhnika*, no. 6, 1978, p. 23-25. In Russian.

The principles of controlling a high-temperature solar installation with parabolic concentrator by means of simultaneous control over the power and density of the radiant flux at the center of the focal plane are developed. It is shown that by this method of power control there is practically no energy redistribution in a circle of radius equal to 0.001 times the ratio of the focal parameter of the parabola generator to the mirror precision measure. P.T.H.

**A79-28670 #** Production and application of rolling-welded aluminum alloy panels for solar water heaters for hot water and cooling systems (Proizvodstvo i primenie prokatnosvarynykh panelei iz aluminievykh splavov dlia solnechnykh vodonagrevatelei sistem goriachego vodosnabzheniya i okhlazhdeniia). N. I. Koriagin, Iu. M. Sigalov, Iu. N. Malevskii, and A. I. Malykhin (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). *Geliotekhnika*, no. 6, 1978, p. 26-31. In Russian.

**A79-28671 #** Study of the temperature distribution across the width of the screen of low-temperature water heaters with tubular heat receivers (K issledovaniyu raspredeleniya temperatury po shirine ekranu nizkotemperaturnykh solnechnykh vodonagrevatelei s trubchatymi teplopriemnikami). G. Ia. Umarov, R. R. Avezov, and N. A. Kakharov (Akademii Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). *Geliotekhnika*, no. 6, 1978, p. 41-46. 7 refs. In Russian.

**A79-28672 #** Study of the spectral characteristics of metallized polymer films for production of solar concentrators (Issledovanie spektral'nykh kharakteristik metallizirovannykh polimernykh plenok dlia izgotovleniya solnechnykh kontsentratorov). A. Iazkulyev, A. A. Trofimova, N. S. Galkina, and M. Kholeva (Akademii Nauk Turkmenской SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR). *Geliotekhnika*, no. 6, 1978, p. 53, 54. 5 refs. In Russian.

**A79-28901 \*** Nuclear Science Symposium, 25th, and Symposium on Nuclear Power Systems, 10th, Washington, D.C., October 18-20, 1978, Proceedings. Symposia sponsored by IEEE, DOE, NASA, and NBS. *IEEE Transactions on Nuclear Science*, vol. NS-26, Feb. 1979, pt. 1. 984 p.

Detectors of various types are discussed, taking into account drift chambers, calorimetry, multiwire proportional chambers, signal processing, the use of semiconductors, and photo/optical applications. Circuits are considered along with instrumentation for space, nuclear medicine instrumentation, data acquisition and systems, environmental instrumentation, reactor instrumentation, and nuclear power systems. Attention is given to a new approach to high accuracy gaseous detectors, the current status of electron mobility and free-ion yield in high mobility liquids, a digital drift chamber digitizer system, the stability of oxides in high purity germanium, the quadrant photomultiplier, and the theory of imaging with a very limited number of projections. G.R.

**A79-28917** 200-kv Blumlein transmission line for ultrafast toroidal theta-pinch. H. Nihei, J. Morikawa, K. Yamazaki, N. Inoue, and T. Uchida (Tokyo, University, Tokyo, Japan). *Electrical Engineering in Japan*, vol. 97, Nov.-Dec. 1977, p. 8-16. 9 refs. Translation.

Blumlein lines are proposed for tokamak plasma heating based on the fact that the Blumlein line (BL) makes it possible to generate a high-speed magnetic pulse very efficiently. Attention is directed to a detailed discussion of the characteristics of the BL and the electromagnetic fields generated by it. The energy transfer efficiency from the BL to the shell (or toroidal one-turn coil) is analyzed theoretically. Equations are derived which can be used for optimization of circuit constants of BL and switches, maximization of energy

transfer efficiency, and analysis of macroscopic mutual interaction between ultrahigh-speed magnetic pulse and plasma. Experimental evidence on the release of hydrogen atoms indicates that the plasma is heated by the magnetic field. S.D.

**A79-28922** Optimum power plant capacity of ocean-based ocean thermal energy conversion systems. T. Kajikawa, T. Agawa, and T. Homma (Ministry of International Trade and Industry, Electrotechnical Laboratory, Tokyo, Japan). *Electrical Engineering in Japan*, vol. 97, Nov.-Dec. 1977, p. 74-81. 11 refs. Translation.

A procedure is proposed to optimize the ocean thermal energy conversion plant capacity on the basis of performance evaluation by the heat transfer area of heat exchanger per net generated output power. This optimization process is illustrated by the example of a plant with total output capacity of 100 MW (working fluid NH<sub>3</sub>). Temperature and pump power allocations and the required dimensions of the optimal plant are derived. Pump powers required for intake of warm and cold water are expressed in terms of water velocity and friction factor. The plant capacity is varied from 1000 MW to 1 MW, and the effects of various factors on plant capacity and generation cost are analyzed. The evaluation function is strongly dependent on the temperature of warm water. S.D.

**A79-28924** Operational characteristics of MHD turbine with air-core superconducting rotor. T. Karasaki and M. Katsurai (Tokyo, University, Tokyo, Japan). *Electrical Engineering in Japan*, vol. 97, Nov.-Dec. 1977, p. 112-119. 10 refs. Translation.

The operational characteristics of an MHD turbine with air-core superconducting magnet are analyzed, with particular attention to the effectiveness of the superconducting rotor for  $Rm$  greater than unity. For this purpose, the effect of the permeability of rotor material is studied using a linear flow model, and the operational characteristics of the MHD turbine with the air-core superconducting rotor are compared with those of an MHD turbine with iron-core superconducting rotor. Only axial flow type machines are considered. It is shown that the output power density of the MHD turbine with the air-core rotor does not decrease even when the  $Rm$ -number is high but increases in proportion to it. Advantages of the air-core rotor machine are established. S.D.

**A79-28983** Feasible operating regions for moving bed coal gasification reactors. H. Yoon, J. Wei, and M. M. Denn (Delaware, University, Newark, Del.). *I & EC - Industrial and Engineering Chemistry, Process Design and Development*, vol. 18, Apr. 1979, p. 306-312. 19 refs. Research supported by the Electric Power Research Institute.

Feasible operating regions for moving bed coal gasification reactors are defined on a triangular diagram of carbon, oxygen, and steam feed ratios. Operability is limited by stoichiometry, thermodynamic equilibrium, and kinetics and physical rate processes. (Author)

**A79-28984** A regenerative process for fluidized-bed combustion of coal with lime additives. R. T. Yang and M.-S. Shen (Brookhaven National Laboratory, Upton, N.Y.). *I & EC - Industrial and Engineering Chemistry, Process Design and Development*, vol. 18, Apr. 1979, p. 312-316. 11 refs.

A regenerative process for fluidized-bed combustion of coal with lime additives has been investigated. This process is based on using carbon for lime regeneration from the sulfated limestone. Ten sulfation/regeneration cycles using Greer limestone have been conducted in a TG system and there was no sign of weakening of the SO<sub>2</sub> sorption activity. Kinetic and mechanistic studies on the regeneration reaction have also been performed, which included the effects of temperature, water vapor, particle size, and catalysts such as sodium chloride. (Author)

**A79-28988** Cogeneration in Europe and the combined cycle gas turbine. R. A. Harmon, C. A. Kinney, and W. M. Crim, Jr. (U.S. Department of Energy, Washington, D.C.). *Turbomachinery International*, vol. 20, Mar. 1979, p. 29-32, 34. 18 refs.

## A79-28989

Simultaneous generation of electricity and useful heat (cogeneration) is known to provide for the maximum utilization of the prime energy supplied as fuel to the conversion system. Cogeneration applications and experience in Western Europe are investigated (for possible use in the USA) in the context of energy conservation, environmental protection, and alternative energy sources. The principal conclusions are presented, noting that the most commonly used types of equipment are back pressure steam turbines or extraction condensing steam turbines. The status and outlook for future application of closed cycle gas turbines in cogeneration systems is considered, indicating that a relatively independent control of electric power and recovered heat should be an important incentive for closed cycle turbines. A.A.

**A79-28989** Gas turbine operating and maintenance experience in Saudi Arabia. A. W. Anderson (Arabian American Oil Co., Technical Services Dept., Dhahran, Saudi Arabia). *Turbomachinery International*, vol. 20, Mar. 1979, p. 66-70.

Operation and maintenance of the gas turbines in Saudi Arabia, utilized to drive crude oil shipping pumps and process gas compressors, are discussed. Operation on wet, sour gas is taken into account, emphasizing the hot corrosion problem and the approaches taken to solve it. Intake air filtration is examined, indicating that as a result of an in depth study it was decided to retrofit the turbines with a three stage air filtration system. The methods for applying corrosion resistant coatings to the blades are considered, as are the overhaul logistics and the repair procedures. A.A.

**A79-29007 \*** Evaluation of MOSTAS computer code for predicting dynamic loads in two-bladed wind turbines. K. R. V. Kaza (NASA, Lewis Research Center, Cleveland; Toledo, University, Toledo, Ohio), D. C. Janetzke, and T. L. Sullivan (NASA, Lewis Research Center, Wind Energy Projects Office, Cleveland, Ohio). In: *Structures, Structural Dynamics, and Materials Conference*, 20th, St. Louis, Mo., April 4-6, 1979, Technical Papers on Structures and Materials. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 53-63. 13 refs. (AIAA 79-0733)

Calculated dynamic blade loads are compared with measured loads over a range of yaw stiffnesses of the DOE/NASA Mod-0 wind turbine to evaluate the performance of two versions of the MOSTAS computer code. The first version uses a time-averaged coefficient approximation in conjunction with a multiblade coordinate transformation for two-bladed rotors to solve the equations of motion by standard eigenanalysis. The results obtained with this approximate analysis do not agree with dynamic blade load amplifications at or close to resonance conditions. The results of the second version, which accounts for periodic coefficients while solving the equations by a time history integration, compare well with the measured data. (Author)

**A79-29064 #** An introduction to the variable inertia flywheel /VIF/. D. Ullman (Union College, Schenectady, N.Y.) and H. Velkoff (Ohio State University, Columbus, Ohio). (*American Society of Mechanical Engineers and Canadian Society for Mechanical Engineering, Applied Mechanics, Fluids Engineering, and Bioengineering Conference*, Niagara Falls, N.Y., June 18-20, 1979, ASME Paper 79-APM-5.) *ASME Transactions, Journal of Applied Mechanics*, vol. 46, Mar. 1979, p. 186-190. 11 refs.

A flywheel with variable moment of inertia, combining the functions of energy storage and power control is introduced. Potential designs are presented and the basic physical governing equations developed. Examples of the flywheel system powering a constant angular rate, frictional load, and an accelerating automobile are presented. Limitations of and potential for future development which become evident in the examples are discussed. (Author)

**A79-29277 #** Optimality criteria in the compensation of the longitudinal boundary effect in induction MHD machines (O

kriteriiakh optimal'nosti pri kompensatsii pro dol'nogo kraevogo effekta v induktsionnykh MGD-mashinakh). Ia. Ia. Valdmanis, R. R. Krishberg, and Ch. K. Mikriukov. *Magnitnaya Gidrodinamika*, Oct.-Dec. 1978, p. 141-143. 7 refs. In Russian.

**A79-29285 #** Calculation of the external electromagnetic field of closely spaced MHD machines (Raschet vneshnego elektromagnitnogo polia blizko raspolozhennykh MGD-mashin). S. M. Apol'tonskii. *Magnitnaya Gidrodinamika*, Oct.-Dec. 1978, p. 88-92. 5 refs. In Russian.

A method is proposed for calculating the combined electromagnetic field of MHD machines located close to each other, by means of correction factors. Correction factors with respect to harmonics are obtained for calculating the combined field of two MHD sources. Illustrative calculations are presented and the results are compared with the experiment. V.P.

**A79-29286 #** Theoretical and computational analysis of MHD machines with two-layer windings and half-filled slots and the inductor edges (Teoreticheskoe i raschetnoe issledovanie MGD-mashin s dvukhslойnymi obmotkami i polupustymi pazami po kraiam induktora). A. I. Vol'dek, N. A. Soldatenkova, and E. V. Tolivinskaya. *Magnitnaya Gidrodinamika*, Oct.-Dec. 1978, p. 101-106. In Russian.

**A79-29287 #** Two asymptotic solutions for analyzing the transverse edge effect in induction MHD machines (O dvukh predel'nykh resheniiakh dlia analiza poperechnogo kraevogo effekta v induktsionnykh MGD-mashinakh). A. P. Raschepkin. *Magnitnaya Gidrodinamika*, Oct.-Dec. 1978, p. 107-111. 5 refs. In Russian.

A comparison is made of the energetic characteristics of an induction machine, calculated on the basis of Okhremenko's (1968) and Veske's (1965) models. It is found that the energetic characteristics differ under conditions of a pronounced transverse edge effect, if the channel width is smaller than or equal to the pole pitch. The results of the two models are practically identical under any conditions, if the gap is smaller and the channel width is larger than twice the pole pitch value. V.P.

**A79-29288 #** Limit of formation of counterflows in plane linear induction MHD machines (Granitsa obrazovaniia protivopravlennykh potokov v ploskolineinykh induktsionnykh MGD-mashinakh). R. R. Krishberg. *Magnitnaya Gidrodinamika*, Oct.-Dec. 1978, p. 112-116. 10 refs. In Russian.

In high-power MHD machines, counterflows may arise at large magnetic Reynolds numbers, due to the demagnetizing action of secondary currents. In the present paper, the limits of formation of secondary flows over the channel width are analyzed. It is shown experimentally that low-power pumps can be used to study such counterflows. In this case, high magnetic Reynolds numbers can be achieved by increasing the frequency. V.P.

**A79-29289 #** Equations of a conduction MHD ejector (Uravnenii konduktionsnogo MGD-streleeniia). Iu. A. Birzalk. *Magnitnaya Gidrodinamika*, Oct.-Dec. 1978, p. 130-134. 10 refs. In Russian.

In the present paper, the linear equations of a classical conduction MHD ejector are obtained in an inductionless approximation, and are found to be analogous to those of an electric two-port network. The conditions for maximum efficiency are derived as a function of the output hydromechanical resistance. A relation for the optimal induction is obtained. The attainable efficiency values are identified, using a numerical example. V.P.

**A79-29297 #** Thermodynamic basis for combining cycles of heat producing power plants (Termodinamicheskie osnovy kombinirovaniia tsiklov teploenergeticheskikh ustanovok). A. I. Andriushchenko (Saratovskii Politekhnicheskii Institut, Saratov, USSR). *Energetika*, vol. 22, Jan. 1979, p. 51-54. In Russian.

The combination of different cycles is discussed as one of the ways of improving the efficiency of thermal power plants. It is shown that estimating fuel economy due to cycle combination

through the increase in thermal efficiency is valid only in the case of combined steam-steam cycles. In the case of superposing a gas cycle on top of a Brayton cycle, the result is not just an increase in thermal efficiency, but also a jump in the specific work of compression, which reduces fuel economy.

P.T.H.

**A79-29298 # Ways of improving steam-gas power plants (Puti sovershenstvovaniia parogazovykh ustanovok).** I. S. Lazarenko, P. E. Kargin, V. T. Iurinskii, P. P. Emets, and I. Ia. Shestachenko (Nevinnomysskaiia GRES, Nevinnomyssk; Novocherkasskii Politekhnicheskii Institut, Novocherkassk, USSR). *Energetika*, vol. 22, Jan. 1979, p. 55-60. 6 refs. In Russian.

It is shown that existing gas turbine systems used in steam-gas power plants can be simplified considerably in their design. Design simplifications are recommended that should reduce the size of gas turbine installations, reduce their metal volume, reduce the amount of assembly labor, and increase cost effectiveness.

P.T.H.

**A79-29313 The economics of hydrogen and carbon monoxide separation with cuprous ammonium lactate solutions.** L. R. Morrison, Jr. and R. I. Kermode (Kentucky University, Lexington, Ky.). *Fuel Processing Technology*, vol. 2, Mar. 1979, p. 79-97. 22 refs.

A process is proposed for making hydrogen from coal which completely eliminates low temperature and reduces the amount of high temperature shift conversion. The resulting 1:1 H<sub>2</sub>-CO mixture is separated by absorption and reaction in a cuprous ammonium lactate solution at 1000 psia. The hydrogen is used for large scale coal liquefaction. Regeneration of the cuprous ammonium lactate solution results in a sulfur and particulate free carbon monoxide stream suitable for electric power generation. A comparison of the economics of this alternative with conventional high and low temperature shift conversion shows an increase in the process efficiency as well as reduction in the amount of capital required. This, plus other savings, results in carbon monoxide costing 0.988 \$/MSCF or 3.095 \$/MM Btu. On an equivalent Btu basis, this is 70.9% of the cost of hydrogen by conventional coal conversion. Thus, substitution of separation for shift conversion results in a substantial product cost reduction.

(Author)

**A79-29314 Coal gasification studies. III - Reduction in the presence of some metal iodides and iron halides.** R. Butler and A. Snelson (IIT Research Institute, Chicago, Ill.). *Fuel Processing Technology*, vol. 2, Mar. 1979, p. 99-121. 15 refs. Research supported by the Consolidated Natural Gas Service Co.

**A79-29315 Reaction mechanism of alkali-alcohol treatment of coal.** M. Makabe and K. Ouchi (Hokkaido University, Sapporo, Japan). *Fuel Processing Technology*, vol. 2, Mar. 1979, p. 131-141. 11 refs. Research supported by the Iwatani Naoji Foundation.

Taiheiyo coal was reacted with ethanol-sodium hydroxide at 260-400 C. for 1-22 hours. The products dissolved almost completely in pyridine. Structural analysis was carried out for the pyridine soluble part to elucidate the reaction mechanism. The only change was a reduction in molecular weight. A very slight saturation reaction of aromatic rings also took place, but this did not affect the structural image of the products very much. The main reaction may be splitting of ether linkages resulting in the reduction of molecular weight and at higher temperature dehydration has followed. This somewhat reduced the solubility in pyridine.

(Author)

**A79-29335 Metropolitan work-trip energy consumption patterns.** S. Soot and A. Sen (Illinois University, Chicago, Ill.). *Traffic Quarterly*, vol. 33, Apr. 1979, p. 275-295. 14 refs. Research supported by the U.S. Department of Transportation.

Patterns of energy consumption for journeys to work in a metropolitan area are examined. The relationship between these patterns and urban structure is demonstrated. Population and

geographic variables that affect energy use are identified by performing statistical and cartographic analyses on census data relating to distances of work trips and choice of transportation mode in the Chicago area. The results obtained verify the expectation that low-density automobile-oriented suburbs are far more energy consumptive than high-density mass-transit-oriented inner-city locations and also indicate that young household heads (aged 25-34) account for a disproportionately high rate of energy use.

F.G.M.

**A79-29337 Application of kinetic energy storage to transportation systems.** L. J. Lawson (AiResearch Manufacturing Company of California, Torrance, Calif.). *High Speed Ground Transportation Journal*, vol. 12, Fall 1978, p. 1-27. 9 refs.

The recent rediscovery of the flywheel as an effective energy storage system, coupled with the growing public and government awareness of the need for energy-efficient passenger vehicles, has led to a resurgence of development activity in kinetic energy storage systems. Programs are currently underway by UMTA and DOE which will make use of pure flywheel and flywheel-assisted propulsion for a wide range of vehicles including subway cars, commuter trains, transit buses, passenger automobiles, and postal vans. The background and status of these ongoing activities is described, along with other planned flywheel applications, such as the recuperation of braking energy from freight trains on long downgrades. (Author)

**A79-29338 The influence of systems and operations on rapid rail energy utilization.** H. L. Tucker, Jr. (U.S. Department of Transportation, Washington, D.C.). *(Advanced Transit Association, International Conference, Indianapolis, Ind., Apr. 25-28, 1978.) High Speed Ground Transportation Journal*, vol. 12, Fall 1978, p. 29-43. 11 refs.

The impacts that the various elements of a rail system have on rail energy intensiveness are investigated. Attention is given to system energy profiles, vehicle weight, propulsion system energy requirements, self-steering trucks, manual vs automatic train control, aspects of system design, operational impacts on energy utilization, programmed acceleration, and scheduling/skip-stop. The individual impacts of systems and operations on rapid rail energy utilization are summarized in a table.

G.R.

**A79-29339 Bus priority system studies.** P. G. Michalopoulos (Minnesota University, Minneapolis, Minn.). *High Speed Ground Transportation Journal*, vol. 12, Fall 1978, p. 45-71.

Priority treatment for buses on urban roadways has been implemented in various forms in an attempt to reduce bus operating costs and encourage ridership. In the reported investigations instrumented buses were employed to study the operational effectiveness of bus priority schemes. The studies were carried out in Miami, Florida, in connection with a demonstration project under the sponsorship of the U.S. and Florida Departments of Transportation. A brief description is given of the operating strategies for the bus priority system which was evaluated. An automated data collection and analysis technique using instrumented buses is discussed and the results of an application of this technique to the evaluation of system effectiveness is considered.

G.R.

**A79-29371 Energy statistics for large wind turbine arrays.** C. G. Justus and A. S. Mikhail (Georgia Institute of Technology, Atlanta, Ga.). *Wind Engineering*, vol. 2, no. 4, 1978, p. 184-202. 8 refs. Contract No. EY-76-S-06-2439.

Results of studies of large arrays of wind energy conversion systems (WECS) are summarized and synthesized into a methodology whereby array wind speed distributions and array power output distributions can be calculated for arrays of any number of sites and any spatial size. Required input for the method consists of: (1) array mean wind speed, (2) maximum distance between sites within an array, (3) number of sites in the array, and (4) standard deviation (or Weibull scale factor), either measured or inferred from reference statistical data. Sample results using this methodology are presented along with sensitivity analyses of the various input parameters. The sensitivity analysis results show that mean wind speed (including its

seasonal and diurnal variation pattern, if important) is the most important factor in the array model. Sensitivity of the array model to other input parameters is about half as much as the mean wind speed sensitivity.

(Author)

**A79-29372** Pressure measurements on wind tunnel models of the Aylesbury experimental house. J. D. Holmes and R. J. Best (North Queensland, James Cook University, Townsville, Australia). *Wind Engineering*, vol. 2, no. 4, 1978, p. 203-220. 10 refs. Research supported by the Australian Housing Research Council.

**A79-29373** Large-scale introduction of wind power stations in the Swedish grid - A simulation study. L. Larsson (Lund Institute of Technology, Lund, Sweden). *Wind Engineering*, vol. 2, no. 4, 1978, p. 221-233.

**A79-29374** Wind power and electric utilities - A review of the problems and prospects. H. Davitian (Brookhaven National Laboratory, Upton, N.Y.). *Wind Engineering*, vol. 2, no. 4, 1978, p. 234-255. 12 refs.

The highly varying character of the power output and the large number of machines required to generate significant amounts of energy are serious obstacles to the large-scale implementation of wind turbines. An attempt is made to summarize several aspects of the current understanding of the potential for and the problems associated with the use of large wind machines. Particular attention is given to the problems related to the use of wind power by electric utilities, as these utilities are the largest potential market for wind machines. To gain insight into these problems, the characteristics of wind variability are explored along with the dynamic aspects of utility operations. Methods and results are outlined of recently completed and ongoing studies which attempt to incorporate the unique characteristics of wind machines into utility analytic techniques with a view to compute realistic estimates of the economic value of wind machines to utilities.

S.D.

**A79-29383 \* #** Effect of broadened-specification fuels on aircraft engines and fuel systems. R. A. Rudey (NASA, Lewis Research Center, Cleveland, Ohio). In: International Symposium on Air Breathing Engines, 4th, Orlando, Fla., April 1-6, 1979, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 53-69. 23 refs. (AIAA 79-7008)

A wide variety of studies on the potential effects of broadened-specification fuels on future aircraft engines and fuel systems are summarized. The compositions and characteristics of aircraft fuels that may be derived from current and future crude-oil sources are described, and the most critical properties that may affect aircraft engines and fuel systems are identified and discussed. The problems that are most likely to be encountered because of changes in selected fuel properties are described; and the related effects on engine performance, component durability and maintenance, and aircraft fuel-system performance are discussed. The ability of current technology to accept possible future fuel-specification changes is discussed, and selected technological advances that can reduce the severity of the potential problems are illustrated.

(Author)

**A79-29384 \* #** Testing to assess the effect of degraded fuel specifications on the cold start ability of a T63-A-700 engine. W. L. Macmillan (Department of National Defence, Ottawa, Canada). In: International Symposium on Air Breathing Engines, 4th, Orlando, Fla., April 1-6, 1979, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 71-77. 7 refs. (AIAA 79-7009)

In the interests of jet fuel availability, the Canadian commercial wide-cut fuel specification has recently been relaxed by increasing the freeze point. An increased freeze point implies an increased low-temperature viscosity and associated cold-starting difficulties. To identify the amount of cold-start degradation to be expected with such fuels, the Canadian Forces commissioned testing to examine the cold start ability of an Allison T63-A-700 turboshaft engine using

four fuels ranging from typical kerosene Jet A-1 to NATO wide cut F-40. The two intermediate fuels were wide cut fuels blended to have specific freeze points agreeing with the new fuel specifications. For the engine under test, the effect of fuel properties on cold-start ability was evident with the relaxed wide-cut fuel producing a 20 C degradation in starting ability compared to the typical NATO F-40 fuel.

(Author)

**A79-29426 \*** Application of the superposition principle to solar-cell analysis. F. A. Lindholm, J. G. Fossum (Florida, University, Gainesville, Fla.), and E. L. Burgess (Sandia Laboratories, Albuquerque, N. Mex.). *IEEE Transactions on Electron Devices*, vol. ED-26, Mar. 1979, p. 165-171. 21 refs. Research supported by the U.S. Department of Energy and NASA.

The superposition principle of differential-equation theory - which applies if and only if the relevant boundary-value problems are linear - is used to derive the widely used shifting approximation that the current-voltage characteristic of an illuminated solar cell is the dark current-voltage characteristic shifted by the short-circuit photocurrent. Analytical methods are presented to treat cases where shifting is not strictly valid. Well-defined conditions necessary for superposition to apply are established. For high injection in the base region, the method of analysis accurately yields the dependence of the open-circuit voltage on the short-circuit current (or the illumination level).

S.D.

**A79-29428** The design and fabrication of CdS/Cu2S cells of 8.5-percent conversion efficiency. W. E. Devaney (SES, Inc., Newark, Del.), A. M. Barnett, J. D. Meakin (Delaware, University, Newark, Del.), and G. M. Storti (Solarax Corp., Rockville, Md.). *IEEE Transactions on Electron Devices*, vol. ED-26, Mar. 1979, p. 205-210. 13 refs. Contract No. E(49-18)-2538.

Changes in CdS/Cu2S solar cell design and fabrication techniques are described which have now resulted in sunlight efficiencies of 8.5%. The efficiency optimization program is based on the detailed energy loss analysis of Rothwarf and Barnett (1977). Three new processing technologies are developed; (1) high-transmission vapor-deposited gold grids are developed for polycrystalline CdS/Cu2S cells without producing efficiency-degrading shorts or shunt resistances; (2) a single-layer antireflection coating of silicon monoxide on a textured cell surface is developed to reduce first surface reflection losses to about 4%; and (3) substantial heat treatments are developed for this cell structure resulting in enhanced Cu2S stoichiometry and corresponding high short-circuit currents. This fabrication technology has resulted in improved cell efficiency while maintaining the previously achieved high degree of cell reproducibility.

S.D.

**A79-29487** International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Conference sponsored by the Chartered Institute of Transport, Electrical Research Association, International Union of Producers and Distributors of Electrical Energy, et al. Hitchin, Herts., England, Peter Peregrinus, Ltd. (PPL Conference Publication, No. 14), 1977. 108 p. \$15.30.

Papers are presented on development work for the implementation of electric road vehicles. Areas dealt with are battery power and economics, operational systems and supply networks, engineering design and power sources, test programs, fleet and individual vehicles and programs of electric vehicle development in various nations. Specific topics considered include lead acid and alkaline batteries, support services for electric vehicles, the compatibility of electric vehicles with an urban environment, electric vehicle design, hybrid vehicles, the implementation of electric bus fleets, and government support for the electric vehicle industry.

A.L.W.

**A79-29488** Prospects for improvements in lead-acid batteries. R. G. Acton and P. Sutcliffe (Oldham and Son, Ltd., Denton, Manchester, England). In: International Conference on Electric

Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 3-5. 5 refs.

The prospects for improving lead acid batteries for electric vehicles in the areas of energy density, recharging time and maintenance are assessed. It is found that battery weight reduction can be achieved by replacing positive grid plates with tubular components, using plastic or lighter metal grids for negative plates and by using 'through the wall' techniques for intercell connectors. An increase in energy density to 45 Wh/kg for a five hour discharge is foreseen. Automatic and semi-automatic watering systems have been developed to reduce the amount of maintenance. Methods proposed to enable rapid charging (in less than an hour) without excessive temperature rise include a system of high speed pulse discharging during the charging process to prevent electrode polarization and a new battery design based on foil technology. A.L.W.

**A79-29489** The energy and resource implications associated with the widespread use of electric vehicles. G. Charlesworth (Open University, Milton Keynes, Bucks., England). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 6-13.

The comparative economics of future internal combustion engine (ICE) and electric battery vehicles are illustrated by a comparison of energy and materials efficiencies. ICE and electric vehicles projected for the years 1990, 2000, and 2025 are compared on the bases of weight, fuel and payload efficiencies, energy demand, total costs and materials requirements. It is concluded that over the next 45 years, electric vehicles using high energy density batteries could be developed and show a significant energy advantage over ICE vehicles fuelled by coal-derived liquids. Unless battery life is extended to more than 500 deep cycles, however, electric vehicles are not likely to show a cash cost advantage. It is noted that electric vehicles will always suffer a range limitation unless extensive battery exchange facilities are established, and implementation would require changes in land use planning and public transportation. A.L.W.

**A79-29490** Recent developments in power sources with special emphasis on alkaline batteries. H. G. Plust (Deutsche Automobilgesellschaft mbH, Esslingen, West Germany). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 14-24. 30 refs.

Recent developments in propulsion batteries for electric road vehicles are discussed, emphasizing alkaline batteries. Lead acid batteries are considered inadequate to meet energy density requirements of 40 to 60 Wh/kg for two-hour discharges and dissolved lead secondary batteries presently suffer from operating problems. In nickel-zinc batteries, nonsintered bonded positive nickel oxide electrodes are being developed to replace expensive sintered electrodes and negative electrodes and cell separators are being improved to prevent shape changes and the formation of dendrites. Larger nickel-zinc batteries (up to 300 Ah for 2 h) are also being produced. Nickel-iron batteries with nickel oxide electrodes are considered to show great promise. Iron-air and zinc-air batteries can achieve high energy densities, but have a low charging/discharging efficiency (29%). Nickel-hydrogen and lithium-water-air batteries are also possible power sources for electric vehicles. A.L.W.

**A79-29491** The role of the battery electric vehicle. G. Ratcliff (Electricity Council, Research Centre, Capenhurst, Cheshire, England). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 29, 30.

Possible applications of battery-powered electric road vehicles are discussed, taking into consideration the limitations imposed by battery parameters. The electric battery requires that electric vehicles be much heavier, have a smaller range and take longer to refuel than gasoline-driven vehicles. The use pattern to which electric vehicles are limited is compatible with such applications as postal delivery vans, light goods service vehicles and urban buses, and is unsuitable for personal private vehicles. It is pointed out that electric vehicles can be designed to have good road performance, with greatest efficiency resulting if the motor operates at high speed with a gear box used to regulate vehicle speed. A conventional van design has been converted to electric power and has been found to have an acceleration of 0 to 30 mph in 12 sec and a maximum speed of 50 mph. A.L.W.

**A79-29492** Support services for electric vehicles. M. Bradford and B. Buss (Electrical Research Association, Ltd., Leatherhead, Surrey, England). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 31-36. 9 refs.

Means of supplying energy to individually owned electric vehicles are examined, emphasizing a system of battery exchange stations. Battery charging in situ where the car is parked has the disadvantages of requiring a considerable amount of time for recharging, making extended journeys inconvenient, and using devices which can be safety hazards. A battery exchange station would charge discharged batteries obtained in exchange for charged ones by means of electricity supplied to the station. A fully automated system can be foreseen for battery handling, which would, however, require standardization of battery and vehicle parameters. The cost of a battery exchange station is considered to be higher than that of a gasoline station, but costs can be minimized by a study of car, battery and station interrelationships. A.L.W.

**A79-29493** Electric vehicles - Can they be fitted into urban Britain. D. Bayliss (Greater London Council, London, England). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 37-45. 35 refs.

The prospects for implementing electric road vehicles in urban Britain, primarily London, are examined. Existing urban travel patterns are analyzed and on the basis of this information a private electric passenger car with a range of 100 km, cruising velocity of 75 km/h and an acceleration of 0 to 65 km/h in 10 sec is specified. In a future system, this car could be complemented by an internal combustion engine car rental service. Electric taxis would be possible if a standardized battery exchange system could be implemented and electric buses and delivery vehicles are also feasible. Present technology, however, does not allow necessary specifications to be met and electric vehicles would not be competitive with diesel-powered vehicles. It is concluded that a spectrum of vehicles, from purely electric through hybrid to purely internal combustion, is most probable for the future. A.L.W.

**A79-29494** Road vehicles with combined, at least partly electrical driving systems and energy supplies. H.-G. Müller (Gesellschaft für elektrischen Straßenverkehr mbH, West Germany). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 48-52. 9 refs.

Systems of combined propulsion, in which one component is electrical, for road vehicles are discussed. The systems consist of a combined energy supply, which can be implemented by means of different kinds of energy (for example electric and diesel power) or by different forms of the same kind of energy (for example overhead wires and batteries), and energy storage systems, including tanks for liquids, metal alloys for the storage of hydrogen as hydrides, electric batteries and mechanical energy storage systems (flywheels). Drive

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systems under consideration, the internal combustion engine and the dc electric motor, are compared. Examples of vehicles with combined propulsion are presented, including a bus run on electricity alternately supplied from overhead wires and an electric battery, and series and parallel variants of internal combustion engine/electric battery powered hybrid vehicles.

A.L.W.

**A79-29495** The fleet operator's viewpoint. A. M. Munro (Greater Manchester Passenger Transport Executive, Manchester, England). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 64-67.

Results of two years operation of two prototype electric buses are discussed. Development of electric buses was undertaken due to the applicability of bus service to electric vehicles and the improvements in reliability and noise expected. Specifications of the two prototype buses are given, noting that both are single-decked, medium sized and employ regenerative braking systems. The performance of the buses was found to be satisfactory, with driver and passenger reactions favorable, however bus availability in both cases was found to be less than 50%, in comparison with a diesel bus availability of 80%. The low availability found is explained by the experimental and unique nature of the equipment. It is concluded that electric buses are possible, but further tests of economic feasibility are required.

A.L.W.

**A79-29496** Developing electric vehicles. G. G. Harding (Lucas Batteries, Ltd., Birmingham, England). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 68-78.

The development of electric battery vehicles undertaken by Lucas Batteries Limited is presented. Early work was done on a test vehicle for a zinc-air battery, but when the battery was abandoned, the experience gained was applied to the conversion to electric power of a pickup truck and two vans. The next stage was to build a number of development vehicles for testing by actual service, with 20 converted vans having achieved over 520 vehicle weeks of service. The design of the most recent vehicles seeks to incorporate an efficient drive system into a standard, relatively low cost, vehicle. Performance tests to be undergone by the latest vehicle are described and possible safety hazards discussed. It has been found that the energy consumption of the electric vehicles is comparable to that of internal combustion engine vehicles, and would be much less if all energy were to come from coal.

A.L.W.

**A79-29497** Latest developments in sponsored test programs for electric vehicles in France. J. Gallot (Electricité de France, Paris, France). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 79-84.

**A79-29498** Electric car project of the Eindhoven University of Technology. W. A. Koomans (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 87-90.

**A79-29499** An electric propulsion system for a town and city bus. C. P. Keizer (Delft, Technische Hogeschool, Delft, Netherlands). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 91, 92.

The design of an electric propulsion system for a city bus is presented and battery parameters are discussed. The bus is designed to accelerate from 0 to 30 km/h in 14 sec, have a maximum speed of 70 km/h and carry a total weight of 16 tons. The motor is a separately excited, continuous 120 kW machine controlled by two

power converters, and regenerative braking is employed. It is calculated that the actual amount of energy that can be extracted from a lead acid battery is 15.3 Wh/kg and about 100 Wh/(ton km) is required for bus operation. A battery mass of 6.5 kg is then required for one ton to be moved one km. If the total mass of the bus is 20 tons (including a trailer for the battery), the actual energy consumption will be 2000 Wh/km and the range with a six ton battery will be 46 km.

A.L.W.

**A79-29575** Energy conversion engineering. R. C. Bailie (West Virginia University; Environmental Energy Engineering, Inc., Morgantown, W. Va.). Reading, Mass., Addison-Wesley Publishing Co. (Energy Science and Technology, No. 1), 1978. 554 p. \$19.50.

The book represents a teaching text and not a state-of-the-art review or a data source book on energy conversion systems. The information presented aims at providing some of the analytical tools that will allow many of the arguments about energy policy to be reduced to numerical values. The discussion covers the laws of thermodynamics, chemical equilibrium, chemical reaction kinetics, and their application to energy conversion systems. Problem areas of interest include combustion of fossil fuel for heat and power, coal gasification and liquefaction, nuclear energy, solar energy, and environmental considerations.

S.D.

**A79-29601** Limits to wind power utilization. M. R. Gustavson (California, University, Livermore, Calif.). *Science*, vol. 204, Apr. 6, 1979, p. 13-17. 35 refs.

The geophysical, environmental and practical factors limiting the total power that can be extracted from the wind are examined. The total power supplied by the sun to the earth is estimated to be  $1.8 \times 10$  to the 17th W, of which  $1.3 \times 10$  to the 15th W is converted to wind energy available at the surface of the earth. It is estimated that 10% of the wind energy available could be utilized without extreme effects on climate, giving a limit of  $1.3 \times 10$  to the 14th W, or  $2 \times 10$  to the 12th W for the land area of the United States. Friction, energy conversion efficiencies, design velocity limits, relations between flow rate and pressure drop, and degradation from packing of collectors reduce the amount of extractable power to about 40% of that available. Even with these limitations imposed, available wind energy is shown to be considerably greater than usable hydropower, geothermal energy and tidal energy.

A.L.W.

**A79-29624** Heat pump technology for saving energy. Edited by M. J. Collie. Park Ridge, N.J., Noyes Data Corp. (Energy Technology Review, No. 39), 1979. 357 p. \$39.

Basic concepts of the heat pump, comparison of water-source and air-source heat pumps in northern environment, and evaluation of the air-to-air heat pump for residential use are described. Attention is given to three experimental studies (residential air-to-air heat pump, water-to-air heat pump using thermal effluent, and heat pump system with thermal storage), to the Annual Cycle Energy System (ACES) water-to-air heat pump unit, and to the solar-assisted heat pump. Also discussed are the performance evaluation of a three-ton air-to-air heat pump, heat pump performance improvement by using a capacity-controlled compressor, and control of the noise generated residential heat pumps.

S.D.

**A79-29625** Passive solar energy design and materials. Edited by J. K. Paul. Park Ridge, N.J., Noyes Data Corp. (Energy Technology Review, No. 41), 1979. 398 p. \$39.

Passive solar approaches are examined, taking into account direct gain, the thermal storage wall, the solar greenhouse, the roof pond, and the convective loop. Various system components are considered. Window treatments are discussed along with thermal storage, freon-activated controls, hinged skylid shutters and nightwall clips, beadwalls, thermic diode solar panels, heat pipes, the Skytherm roof pond, the energy roof, Suncatcher and Cool Pool, and the solar room. A description is provided of case studies and applications. Attention is given to direct gain, indirect gain, and isolated gain.

G.R.

**A79-29647** Symmetrical and asymmetrical ideal cylindrical radiation transformers and concentrators. D. R. Mills and J. E. Giutronich (New South Wales, University, Kensington, Australia). *Optical Society of America, Journal*, vol. 69, Feb. 1979, p. 325-328. 7 refs.

Ideal cylindrical radiation transformers and concentrators are examined in both asymmetrical and symmetrical forms. Symmetrical ideal transformers are found to give the lowest peak concentration for a given angle of acceptance. Average concentration for uniform diffuse radiation or a distant point source of constant apparent angular velocity is found to be independent of the symmetry of the transformer; for an apparently accelerating source such as the sun, however, an asymmetrical transformer can give higher performance than a symmetrical unit when averaged over time. (Author)

**A79-29794** Feasibility of MHD-ac induction electric power plant. K. Denno (New Jersey Institute of Technology, Newark, N.J.). In: Canadian Communications and Power Conference, Montreal, Canada, October 18-20, 1978, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 349-352. 5 refs.

The reported investigation deals with real and factual situations for the effective utilization of a rich conducting plasma located in the divertor channel and exhaust chamber of the tokamak fusion reactor. The exhaust chamber, which is almost of cylindrical geometry, is expected to serve as the operating MHD channel with the conducting plasma entering at circumferential velocity. The exciting field is generated by a time-varying sinusoidal current sheet. Specific and procedural solutions are presented for the cylindrical distribution of the applied and induced magnetic fields, the induced current density and voltage, and the generated ac power output. G.R.

**A79-29795** Development and application of techniques to evaluate cogeneration impacts. F. E. Wicks, W. Rutz, M. Becker, J. Sergison, G. Mulligan, and S. Yerazunis (Rensselaer Polytechnic Institute, Troy, N.Y.). In: Canadian Communications and Power Conference, Montreal, Canada, October 18-20, 1978, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 357-360.

Cogeneration is the simultaneous production of electric energy and process heat from a single plant. Usually the higher temperature heat powers the electric generation and the lower temperature exhaust provides the process heat. These classes of cogeneration are called topping cycles. There are also some processes that require high temperature heat and thus the electric generating engine can be driven by the intermediate temperature discharge heat from the process. These classes of cogeneration are called bottoming cycles. All fuel consuming electric generating engines or drivers can be applied to cogeneration. Attention is given to cogeneration operating patterns and the impact of cogeneration upon the existing system.

G.R.

**A79-29796 \*** Space solar power - An energy alternative. R. W. Johnson (NASA, Washington, D.C.; Grumman Aerospace Corp., Bethpage, N.Y.). In: Canadian Communications and Power Conference, Montreal, Canada, October 18-20, 1978, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 369-372.

The space solar power concept is concerned with the use of a Space Power Satellite (SPS) which orbits the earth at geostationary altitude. Two large symmetrical solar collectors convert solar energy directly to electricity using photovoltaic cells woven into blankets. The dc electricity is directed to microwave generators incorporated in a transmitting antenna located between the solar collectors. The antenna directs the microwave beam to a receiving antenna on earth where the microwave energy is efficiently converted back to dc electricity. The SPS design promises 30-year and beyond lifetimes. The SPS is relatively pollution free as it promises earth-equivalence of 80-85% efficient ground-based thermal power plant. G.R.

**A79-29797** Some recent developments in wind and ocean power systems. J. T. Yen (Grumman Aerospace Corp., Bethpage, N.Y.). In: Canadian Communications and Power Conference, Montreal, Canada, October 18-20, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 373-377. 6 refs.

A description is presented of a tornado-type wind energy system and its extension. Immense amounts of wind energy will be collected by a stationary and omni-directional collector which is a slotted cylinder fitted with adjustable vanes at its periphery. Collected wind energy is guided by the vanes to form a vortex or a 'confined tornado' within the collector. The low-pressure core of the vortex is then used to greatly reduce the back pressure of a turbine which is located directly below the vortex core. The underside of the turbine is connected to the ambient atmosphere through a bottom inlet.

G.R.

**A79-29798** Control problems of the magnetohydrodynamic electrical power generation in power station cooperating with electrical power system. J. Stiller, A. Grzybowski, and I. Grzadzieski (Poznan, Politechnika, Poznan, Poland). In: Canadian Communications and Power Conference, Montreal, Canada, October 18-20, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 378-381. 5 refs.

**A79-29799** A Variable Speed Constant Frequency /VSCF/ wind generator for low power applications. V. I. John and J. Sones (Queen's University, Kingston, Ontario, Canada). In: Canadian Communications and Power Conference, Montreal, Canada, October 18-20, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 382-385.

A polyphase commutator motor of the Schrage type is used as a Variable Speed Constant Frequency (VSCF) wind generator. An automatic control system which maintains continuous generator operation for a wide range of speeds is described. Test results and computed results (based on an equivalent circuit) are obtained for efficiency, power output, powerfactor and mechanical torque for different operating speeds, to demonstrate the feasibility of Schrage generator for windpower applications.

(Author)

**A79-29800** Control strategy for a variable-speed wind energy conversion system (Stratégie de commande pour un système de conversion de l'énergie éolienne à vitesse variable). A. Jacob, D. Veillette, and V. Rajagopalan (Québec, Université, Trois-Rivières, Canada). In: Canadian Communications and Power Conference, Montreal, Canada, October 18-20, 1978, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 528-531. 10 refs. In French. Research supported by the Department of Energy, Mines, and Resources, National Research Council and Université du Québec.

A control concept for a variable-speed wind energy conversion system is proposed, for which a self-excited asynchronous cage generator is used along with a system of thyristor converters. The control loops are the following: (1) regulation of the entrainment speed as function of available mechanical energy by acting on the resistance couple of the asynchronous generator; (2) control of electric power delivered to the asynchronous machine, functioning as a motor, for startup of the vertical axis wind converter, and (3) limitation of the slip value, and by consequence, of the induction currents in the presence of sudden variations of input parameters.

P.T.H.

**A79-29936 #** Remote sensing and mine subsidence in Pennsylvania. O. R. Russell (Earth Satellite Corp., Washington, D.C.), R. V. Amato, and T. V. Leshendok (U.S. Geological Survey, Washington, D.C.). (*American Society of Civil Engineers, National Spring Convention and Continuing Education Program, Pittsburgh, Pa., Apr. 24-28, 1978.*) ASCE, *Transportation Engineering Journal*, vol. 105, Mar. 1979, p. 185-198.

## A79-29939

It is pointed out that during the more than 200 years of mining activity in the Northern Anthracite Field of Pennsylvania more than 50% of the original anthracite reserves have been removed. This undermining of the area has caused much subsidence, which in many instances has damaged streets, railroads, private property, and sections of the extensive river flood-prevention system. Mine subsidence is a continuing problem. The U.S. Bureau of Mines estimates that by the year 2000, over 1,500,000 acres of land will have been affected. Subsidence hazards data are essential to state and local planning agencies before any major construction can be undertaken. In an attempt to determine a more efficient and cost effective means of identifying subsidence problem areas, the utility of aerial remote sensing has been examined. The underlying strategy of the project was to recognize that the overall problem is to develop a better approach to land-use management. G.R.

**A79-29939** The impact of alternate energy resources on the future supply of electric power. J. A. Belding (U.S. Department of Energy, Div. of Power Systems, Washington, D.C.); (*Institute of Electrical and Electronics Engineers, Summer Meeting, Los Angeles, Calif., July 16-21, 1978, Paper F 78 672-8.*) *IEEE Transactions on Power Apparatus and Systems*, vol. PAS-98, Mar.-Apr. 1979, p. 554-559; Discussion, p. 559, 560. 21 refs.

Given the limitations of the import solution, and the declining domestic supply of oil and natural gas, it is apparent that a shift must occur to alternate fuel resources, coal and nuclear for now, and solar and geothermal in the future. The adoption of these alternate fuels will not be easy, however. It will be constrained by a number of technological and nontechnological problems. The reported investigation deals partly with the technological dimensions of coal and nuclear electricity generation. However, the nontechnological problems are also considered, giving attention to environmental, economic, foreign policy, and security issues. G.R.

**A79-29942 #** Homopolar generator energy storage for fusion reactors. E. K. Inall (Australian National University, Canberra, Australia). *Institution of Engineers (Australia), Electrical Engineering Transactions*, vol. EE 14, no. 2, 1978, p. 83-87.

The paper outlines the design features of the 560-MJ homopolar generator (HPG) presently operating at the Australian National University. There are four or five types of plasma machine for which the ongoing programs aim at the construction of fusion power reactors. Three of these, namely tokamaks, stellarators and theta pinches need the energy storage which HPGs can provide. The design of HPGs to suit the needs of such machines is considered. S.D.

**A79-29974** Instrumentation for in situ coal gasification. IV - Seismic and acoustic techniques for remote monitoring. L. W. Beckham, H. D. Garbin, and D. A. Northrop (Sandia Laboratories, Albuquerque, N. Mex.). *In Situ*, vol. 3, no. 1, 1979, p. 1-31. 16 refs.

**A79-29975** Oil shale retorting - A correlation of selected infrared absorbance bands with process heating rates and oil yield. R. A. Evans and J. H. Campbell. *In Situ*, vol. 3, no. 1, 1979, p. 33-51. 8 refs. Contract No. W-7405-eng-48.

**A79-30123 #** Thermal conductivity of crystalline rocks associated with energy extraction for hot dry rock geothermal systems. W. L. Sibbitt, J. G. Dodson, and J. W. Tester (California, University, Los Alamos, N. Mex.). *Journal of Geophysical Research*, vol. 84, Mar. 10, 1979, p. 1117-1124. 25 refs. Research supported by the U.S. Department of Energy.

**A79-30172** The potential for solar energy development. P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). *Technology in Society*, vol. 1, Spring 1979, p. 55-66. 12 refs.

The costs of solar water and space heating installations for residences and commercial buildings are discussed, and the develop-

ment programs for Solar Power Satellites are reviewed. Projected U.S. electrical generating capacities from wind power, solar thermal power, photovoltaics, ocean thermal energy, biomass conversion and Solar Power Satellites are reported for the years 2000 and 2020. The role of Solar Power Satellites in providing electrical generating capacity for the U.S. may be significant by 2020. J.M.B.

**A79-30175** Energy, resources, and policy. R. C. Dorf (California, University, Davis, Calif.). *Reading*, Mass., Addison-Wesley Publishing Co., Inc., 1978. 500 p. 472 refs. \$15.95.

The book is an introduction to the uses of energy, supplies of fossil fuels, alternative energy sources, and various policy alternatives for the U.S.A. and the world. The history of energy use and projections for future consumptions are outlined. The fossil fuels are discussed along with electric power as a carrier of energy. The uses of energy in transportation and agriculture are explored. Hydroelectric, wind, tidal, geothermal, and nuclear power generating techniques are emphasized. Solar energy methods are considered along with alternative conversion and storage systems. Attention is given to the conservation of energy as well as to the relationship of energy and the environment. Also discussed are energy economics, policy and underlying international factors. S.D.

**A79-30204 #** Utilisation of solid waste. K. Balu (Regional Research Laboratory, Computer Div., Hyderabad, India). *Indian Journal of Air Pollution Control*, vol. 1, July 1978, p. 109-114. 5 refs.

The prime solution to the present energy crisis is the recovery of latent energy from waste materials, for solid waste contains recoverable energy and it merely needs to be released. The paper is concerned with classification of solid waste, energy content of waste, methods of solid waste disposal, and chemical processing of solid waste. Waste disposal must be performed in situ with energy recovery. Scarcity of available land, pollution problem, and unrecovered latent energy restrict the use of the land-filling method. Pyrolysis is an effective method for the energy recovery and disposal problems. Chemical processing is suitable for the separated cellulosic fraction of the waste material. S.D.

**A79-30207** Study of the characteristics of Ni-Cd storage batteries for space applications (Estudio de las características de las baterías Ni-Cd de utilización espacial). M. Peralta Bellido. *Inta/Conie*, July-Dec. 1978, p. 26-39. 8 refs. In Spanish.

An investigation is conducted of the main characteristics which have to be considered in the selection of nickel-cadmium batteries for space applications, taking into account the results which were obtained in tests in which batteries were kept on board of a satellite in geostationary orbit. Attention is given to the potential of a cell on the basis of free energy considerations, the evolution of heat in a cell, the internal pressure of the sealed cells, and details concerning the experiments in which the cells were in geostationary orbit. The behavior of the various parameters during the tests is illustrated with the aid of a number of graphs and tables. G.R.

**A79-30215** Electrical induction heating of solid fossil fuels in situ - Some estimates. S. T. Fisher (F. T. Fisher's Sons, Ltd., Montreal, Canada). *Speculations in Science and Technology*, vol. 1, Dec. 1978, p. 441-451. 5 refs.

It is believed that the world has adequate reserves of solid fossil fuels to supply it with energy and petrochemicals for centuries. A proposed in-situ technique for high-yield low-cost clean exploitation, electrical induction heating, is described. This method consists of shafts and tunnels encompassing the fuel deposit drilled from the surface, with electrical conductors, forming a coil that may be a kilometer or more in diameter, threaded through these openings. A large alternating current passed through the coil sets up alternating electric and magnetic fields in the solid fossil-fuel deposit. These fields induce currents in the electrically dissipating material. These currents then heat the material so that the energy content of the fuel

can be brought to the surface in the form of gaseous hydrocarbons, steam, or hot gas to be utilized there by conventional methods. This process may double or triple the recovery rates of present solid-fuel extraction methods, at lower cost and with less human and environmental damage than is presently the case.

(Author)

**A79-30258** Ga<sub>1-x</sub>Al<sub>x</sub>As-GaAs photovoltaic cells with multilayer structure. S. Panyakeow, J. Shirafuji, and Y. Inushi (Osaka University, Suita, Japan). *Journal of Physics D - Applied Physics*, vol. 12, Mar. 14, 1979, p. 437-440. 12 refs.

Liquid phase epitaxy was used to fabricate multilayer Ga(1-x)Al(x)As-GaAs heterostructure solar cells. A cell with three layers of Ga(1-x)Al(x)As ( $x = 0.2, 0.13$ , and  $0.07$ ) without antireflection coating gave a much better performance than the one-layer Ga(1-x)Al(x)-GaAs ( $x = 0.2$ ) cell and had a conversion efficiency of 15%.

B.J.

**A79-30259** The limiting efficiency of an edge-illuminated multigap solar cell. J. E. Parrott (University of Wales Institute of Science and Technology, Cardiff, Wales). *Journal of Physics D - Applied Physics*, vol. 12, Mar. 14, 1979, p. 441-450. 6 refs.

An edge-illuminated multigap photovoltaic system should show an efficiency greater than that attainable with only a single gap. The theoretical upper limit to the efficiency will occur as the number of different gaps goes to infinity. For this case a detailed balance limit analysis shows that at one sun the predicted efficiency is 64%, increasing with intensity to 81% at 10,000 suns. The effects of stimulated emission are included in the calculations but are found to be negligible.

B.J.

**A79-30264** # Problems in the use of cryogenic pumps in thermonuclear synthesis (Проблемы применения криогенных насосов в термоядерном синтезе). B. V. Glasov, O. S. Drui, V. I. Kurnosov, E. I. Skibenko, L. G. Sorokovoi, Iu. V. Khodol, and V. B. Iuferov (Академия Наук Украинской ССР, Физико-Технический Институт, Харьков, Украинская ССР). *Ukrainskii Fizicheskii Zhurnal*, vol. 24, Jan. 1979, p. 87-93. 20 refs. In Russian.

On the basis of certain design figures for a thermonuclear reactor and assumptions regarding the temperature of the plasma near the pump system, various processes taking place in the vacuum system and the cooling system are studied. It is shown that there are several effects which could contribute simultaneously to an intensification of the desorption of condensate and to the growth of the absolute value of the heat removal.

P.T.H.

**A79-30331** Discharge reaction mechanisms in Li/SOCl<sub>2</sub> cells. C. R. Schlaikjer, F. Goebel, and N. Marinic (General Telephone and Electronics Laboratories, Inc., Waltham, Mass.). (*Electrochemical Society, Meeting, Atlanta, Ga., Oct. 9-14, 1977.*) *Electrochemical Society, Journal*, vol. 126, Apr. 1979, p. 513-522. 40 refs.

Experimental results show that Li/SOCl<sub>2</sub> soluble cathode power sources operating at room temperature do not generate appreciable amounts of lithium sulfur oxyacid salts. SO<sub>2</sub> is produced but at a rate less than that predicted by 4Li + 2SOCl<sub>2</sub> yields S + SO<sub>2</sub> + 4LiCl until near the end of the discharge. The measured number of equivalents per mole of SOCl<sub>2</sub> is near 2. It is possible that SO or an SO polymer is formed during discharge which remains in solution. Cells operating at -20°C produce at least one lithium sulfur oxyacid salt, possibly Li<sub>2</sub>SO<sub>3</sub>, as indicated by chemical analysis of cathodes taken from discharged 2D cells.

B.J.

**A79-30332** A lithium/dissolved sulfur battery with an organic electrolyte. R. D. Rauh, K. M. Abraham, G. F. Pearson, J. K. Surprenant, and S. B. Brummer (EIC Corp., Newton, Mass.). (*Electrochemical Society, Meeting, Philadelphia, Pa., May 8-13, 1977.*) *Electrochemical Society, Journal*, vol. 126, Apr. 1979, p. 523-527. 26 refs. Contract No. EY-76-C-02-2520.

The feasibility has been demonstrated of a high energy density Li battery with an Li<sub>2</sub>Sn positive electrode dissolved in an organic

electrolyte. Virtually 100% of the theoretical capacity could be realized at 50°C at rates below 1.0 mA/sq cm. In high-rate cell configurations 75% cathode utilization is possible at about 4 mA/sq cm. The capacities at high rate are enhanced by Lewis acids, although the ultimate cause of rate limitation is passivation of the current collector by discharge products. Based on the experimental results, a practical energy density of about 300 W-hr/kg is possible using a standard cell design.

B.J.

**A79-30333** Steady-state composition profiles in mixed molten salt electrochemical devices. II - Molten carbonate fuel cell analogs. C. E. Vallet and J. Braunstein (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *Electrochemical Society, Journal*, vol. 126, Apr. 1979, p. 527-534. 13 refs. Contract No. W-7405-eng-26.

Steady-state equations, derived previously for composition gradients in battery analogs with binary mixtures of molten salts as electrolytes, have been modified to apply to molten carbonate fuel cells. Since neither of the two like-charged cations of the electrolyte reacts at the electrodes, the concentration gradient arises only from the difference in the mobilities of the two cations. Conditions of current density, electrode separation, electrolyte composition, and temperature that favor either steady state or precipitation of a solid phase are presented in parametric form. Numerical solution of the diffusion-migration equation is used to predict the development with time of the concentration gradient. The computation also simulates the variations with time of emf between anode and cathode both during current flow and during the subsequent decay on open circuit. An electrochemical method for estimation of the interdiffusion coefficient and the ion mobility ratio in a binary electrolyte is outlined.

(Author)

**A79-30345** Regulation and control concepts for the possibilities of a utilization of solar energy in the low-temperature range (Regelungstechnische und steuerungstechnische Konzepte für Nutzungsmöglichkeiten der Sonnenenergie im Niedertemperaturbereich). S. Fischer (Aachen Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany). *VDI-Z*, vol. 121, no. 5, Mar. 1979, p. 203-208. 17 refs. In German.

The employment of regulation and control techniques for processes related to the utilization of solar energy in the low-temperature range is considered. It is found that regulation and control concepts in this area do not yet have the importance which they should have in connection with the significance of high-intensity cyclic and stochastic disturbing quantities. The possibilities for a utilization of solar energy are considered and various solar-energy collector types are examined. The direct utilization of solar radiation by means of solar collectors is discussed, taking into account the solar collector as part of the control system and the regulation and control of the solar-energy collector cycle. Aspects concerning the indirect utilization of solar energy by means of air-water-heat pump systems are also explored. Attention is given to the heat pump as part of a control system, an improvement of heat pump control, and the control concept of a heating cycle using a heat pump.

G.R.

**A79-30374** Sail power for the world's cargo ships. L. Bergeson. *Technology Review*, vol. 81, Mar.-Apr. 1979, p. 22-36. 8 refs.

The potential of sail power for commercial ships is examined. The 'Preussen' and the 'Thomas W. Lawson' sail vessels, built in 1902, capable of carrying over 8000 long tons of cargo and with a theoretical hull speed of about 22 knots, are described. Recent research on designing advanced sailing ships is considered, noting that sail power is expected to be much more economical than a fossil fuel power plant under selected conditions. A program for conversion to sail power is reviewed, indicating that the first phase includes studies of potential routes where ships up to 2000 deadweight tons would be most competitive. Projected parameters for ship design, rig, cargo handling, and stowage are considered in the light of two prototype vessels, the single hull and the catamaran. Operation of the future

## A79-30391

sailing ships is taken into account, and proposals for further research are noted.

A.A.

**A79-30391** # Mechanism of erosion of metal electrodes of the channel of a MHD generator. I. I. Beilis (Akademii Nauk SSSR, Institut Vysokikh Temperatur, Moscow, USSR). (*Teplofizika Vysokikh Temperatur*, vol. 16, July-Aug. 1978, p. 848-853.) *High Temperature*, vol. 16, no. 4, Jan. 1979, p. 723-727. 13 refs. Translation.

The erosion of a cathode caused by slowly moving arc spots burning in the combustion products with potassium seeding in the channel of a magnetohydrodynamic (MHD) generator was investigated. On the basis of a numerical analysis of a system of equations for the cathode region of the investigated type of spots it is shown that erosion of the electrode is determined largely by its emission properties and is caused by vaporization of the cathode material. Appropriate processing of the results of experiments conducted on various MHD devices made it possible to establish the presence of a characteristic (for the investigated conditions) value of the work function of a cathode covered with potassium seed. (Author)

**A79-30392** Comparison of results of calculation of flow in an MHD generator with experimental data obtained on the U-25 device. V. A. Bitiurin, V. A. Zhelnin, G. A. Liubimov, and S. A. Medin (Akademii Nauk SSSR, Institut Vysokikh Temperatur; Moskovskii Gosudarstvennyi Universitet, Moscow, USSR). (*Teplofizika Vysokikh Temperatur*, vol. 16, July-Aug. 1978, p. 854-867.) *High Temperature*, vol. 16, no. 4, Jan. 1979, p. 728-739. 10 refs. Translation.

A method is presented and results given for comparison of a calculation of hydraulic flow with experimental data obtained using the U-25 device. It is shown that the hydraulic model used for calculation permits a completely satisfactory description of plasma flow in a 1D Faraday channel and in framed R and RM channels. As a result of comparing calculation with experiment, values are established for a number of empirical quantities contained in the equations in the hydraulic model. The meaning and range of applicability of the quantities so obtained are discussed, as are possible ways of perfecting the hydraulic model. (Author)

**A79-30484** # Very large vehicles - To be or. W. H. Arata, Jr. (Northrop Corp., Los Angeles, Calif.). *Astronautics and Aeronautics*, vol. 17, Apr. 1979, p. 20-25, 33. 20 refs.

Some of the concepts being studied for large aircraft are briefly discussed. Concepts for conventional takeoff and landing aircraft, distributed-load aircraft, wing-in-ground effect aircraft, multiple fuselages, the laminar-flow-control aircraft, nuclear powered tug, air-cushion-landing-system aircraft, blimp-helicopter combination, and surface-effect ships are mentioned. P.T.H.

**A79-30485** # Large-vehicle concepts. L. W. Noggle (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio) and C. E. Jobe (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *Astronautics and Aeronautics*, vol. 17, Apr. 1979, p. 26-32. 18 refs.

The paper briefly surveys most of the very large vehicle concepts examined by Air Force, Navy, NASA, and industry in recent study efforts. Some of these include a conventional aircraft capable of carrying a 400,000-lb load over a range of 6200 n. mi., a laminar flow control aircraft, where slotted wing and tail surfaces provide laminar flow to 70% chord to conserve fuel, nuclear-powered aircraft with active-controls technology, swept-wing space-distributed-load aircraft capable of carrying a million pounds of payload, wing-in-ground-effect vehicles, a power-augmented-ram/wing-in-ground-effect vehicle, and the heavy-lift airship. P.T.H.

**A79-30502** # Measured effects of flow leakage on the performance of the GT-225 automotive gas turbine engine. C. C. Matthews (GM Research Laboratories, Warren, Mich.). *American*

*Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-3.* 5 p. Members, \$1.50; nonmembers, \$3.00.

**A79-30505** # The combined reheat gas turbine/steam turbine cycle. I - A critical analysis of the combined reheat gas turbine/steam turbine cycle. I. G. Rice. *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-7.* 7 p. 14 refs. Members, \$1.50; nonmembers, \$3.00.

**A79-30506** # The combined reheat gas turbine/steam turbine cycle. II - The LM 5000 gas generator applied to the combined reheat gas turbine/steam turbine cycle. I. G. Rice. *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-8.* 8 p. 6 refs. Members, \$1.50; nonmembers, \$3.00.

**A79-30510** # The application of indirectly fired open cycle gas turbine systems utilizing atmospheric pressure fluidized bed combustors to industrial cogeneration situations. C. L. Marksberry and B. C. Lindahl (FluiDyne Engineering Corp., Minneapolis, Minn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-16.* 10 p. 6 refs. Members, \$1.50; nonmembers, \$3.00.

**A79-30522** # Conceptual design of a solar powered closed-cycle gas turbine electric power generation system. T. L. O. Horton, S. C. Kuo, H. T. Shu, and E. R. Fisher (United Technologies Research Center, East Hartford, Conn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-43.* 12 p. 10 refs. Members, \$1.50; nonmembers, \$3.00. Research sponsored by the U.S. Department of Energy.

The conceptual design characteristics of a closed-cycle gas turbine system suitable for solar electric power generation are presented in this paper. The conceptual designs for both the gas turbine and the heat exchangers required to provide an integrated power conversion system are presented. Technology projected for 1985 availability was utilized in these designs to provide a cost-effective installation in the 1990 time frame. This task was made more credible by the utilization of air rather than helium as the working gas since the vast majority of required technology is well known and available. Also presented are potential power conversion system part-load performance, component layout, and operating characteristics resulting from this conceptual design which allow evaluation of the feasibility of their integration into a total solar plant installation. (Author)

**A79-30530** # Study of integrated gasification combined cycle plant interaction and control. D. J. Ahner, A. S. Patel (General Electric Co., Schenectady, N.Y.), and G. Quentin (Electric Power Research Institute, Palo Alto, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-60.* 9 p. 8 refs. Members, \$1.50; nonmembers, \$3.00.

This paper discusses the model features and preliminary results of an analytical simulation control study of an integrated gasification combined cycle plant, incorporating air blown, fixed bed gasifiers. The general scope of the study effort and the model capabilities are discussed. In addition, dynamic simulations utilizing various fuel system subloop and station control logic are presented and their implications with respect to power system response and fuel system excursions are described. (Author)

**A79-30532** # Investigation of the heat transfer in cylindrical receiver configurations with inner tubes. K. Bammert, R. Krapp, and P. Seifert (Hannover, Universität, Hannover, West Germany). *American Society of Mechanical Engineers, Gas Turbine Conference and*

*Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-64.* 9 p. 11 refs. Members, \$1.50; nonmembers, \$3.00.

The design of a receiver for a closed-cycle gas turbine with air as the working medium is discussed. The emphasis of the investigations is layed upon the optimization of heat transfer to the working medium. The irradiation pattern along the tubes and the effects of the working-medium pressure, the pressure loss and the tube cage geometry are considered. (Author)

**A79-30533 # Soot and the combined cycle boiler.** P. B. Roberts (Solar Turbines International, San Diego, Calif.) and H. D. Marron (U.S. Navy, Naval Ship Engineering Center, Washington, D.C.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-67.* 10 p. 5 refs. Members, \$1.50; nonmembers, \$3.00. Contract No. N0024-77-C-4366.

Liquid-fueled gas turbines can produce serious steam generator fouling in combined cycle applications and other waste heat recovery systems as a result of combustion system generated soot particles. In addition, standard soot blowing particles are not always compatible with the advanced, compact matrix designs sometimes required for minimum package size applications. This paper describes an experimental program conducted on both test rigs and engine hardware designed to evaluate the effects on gas side soot fouling rates of various operational parameters such as soot loading, temperature and velocity. Particular attention is given to the effectiveness of the self-cleaning concept where elevated steam generator metal temperatures are utilized to remove soot deposits. (Author)

**A79-30536 # Water-cooled gas turbine technology development - Fuels flexibility.** M. W. Horner, W. H. Day (General Electric Co., Gas Turbine Div., Schenectady, N.Y.), D. P. Smith (GE Corporate Research and Development Center, Schenectady, N.Y.), and A. Cohn (Electric Power Research Institute, Palo Alto, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-72.* 15 p. 9 refs. Members, \$1.50; nonmembers, \$3.00.

It is pointed out that water cooling of commercial heavy-duty gas turbine hot section components offers a number of potential advantages over air cooling. Cycle performance will be improved because turbines can be operated at higher firing temperatures and pressure levels and reliability will be increased because of the reduction in component metal temperatures. Heavy or contaminated fuels will be accommodated because cooling holes will be eliminated and because the low surface metal temperatures decrease the corrosion rate and the ash deposition rate. A description is presented of the results obtained from the continuation of a water-cooled gas turbine development program and other related parallel programs. The major concern is with the potential of water-cooled technology for improving turbine tolerance to contaminants in petroleum and coal-derived fuels. G.R.

**A79-30537 # A multivariable controller for an automotive gas turbine.** D. E. Winterbone, N. Munro, and D. J. Nuske (University of Manchester Institute of Science and Technology, Manchester, England). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-73.* 14 p. 14 refs. Members, \$1.50; nonmembers, \$3.00.

A complete control system design study is described, starting with a non-linear mathematical model and finishing with the control hardware. The basic objective of the study was to design a controller which reduced the characteristically poor response of the two-shaft automotive gas turbine. This was achieved by identifying the reasons for the acceleration delay and then designing the controller to compensate for them. The gas turbine was simulated by means of a quasi-steady non-linear thermodynamic model implemented on a digital computer. Careful manipulation of the equations enabled the model to run in real-time. This model was linearized at various

operating points and the transfer functions obtained were compared with those measured on the plant. The control system was designed using Rosenbrock's multivariable inverse Nyquist array technique. These compensators were grafted onto the original single loop control box and fitted to the engine. The results obtained on the engine test bed are compared with those using the original controller. A very large reduction in response lag is obtained with the multivariable control system. (Author)

**A79-30539 # A flywheel energy storage and conversion system for solar photovoltaic applications.** A. R. Millner (MIT, Lexington, Mass.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-1.* 10 p. Members, \$1.50; nonmembers, \$3.00. Research sponsored by the U.S. Department of Energy.

A low-drag, low-power magnetic bearing and a permanent magnet brushless d-c motor-generator have been developed for a satellite flywheel. These will be combined with a terrestrial flywheel and control electronics to make up a flywheel energy storage and conversion system for use in a stand-alone solar photovoltaic residence. Technical and economic performance analyses indicate that, contrary to general thought, a flywheel system will be competitive if not superior to more conventional systems utilizing either present-day or advanced batteries. This derives from the ability of the flywheel to perform the functions of d-c to a-c inversion and optimal impedance matching between the PV arrays and the load in addition to providing energy storage. The motor-generator design will also be discussed. This paper describes the structural topology, performance data, design parameters, and test measurements of the magnetic bearing and motor-generator as well as a description of the flywheel and control electronics to be used. A preliminary discussion of the economic aspects is also included. (Author)

**A79-30540 # Design considerations of small solar collector systems using plane heliostats.** K. J. Waldron, A. C. Meyers (Houston, University, Houston, Tex.), and K. Kheyrandish. *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-2.* 10 p. 8 refs. Members, \$1.50; nonmembers, \$3.00.

The primary advantage of the central receiver concept is the minimization of heat transmission in the form of enthalpy of a working fluid. This is replaced by efficient and low cost optical energy transmission. This characteristic renders collectors using heliostats to reflect solar radiation onto a stationary receiver attractive for small to medium scale, as well as large scale collection. This paper describes several years of design studies and simulations of central receiver systems scaled to be suitable for heating and cooling of commercial buildings or for some industrial process heat applications. The relatively small distances between the heliostats and receiver, vertical flat plate receiver geometry, and relatively low receiver result in optical simulation characteristics of such systems quite different to those of the large solar tower systems. The variation in radiation intensity over the surface of the receiver due to the relatively irregular shape of the isolated patch from a heliostat segment, and due to dispersion produced by off axis aberration in segmented heliostats, requires several unique features in the receiver design. (Author)

**A79-30541 # Solar Rankine engines - Examples and projected costs.** R. E. Barber (Barber-Nichols Engineering Co., Arvada, Colo.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-3.* 10 p. 8 refs. Members, \$1.50; nonmembers, \$3.00.

The Organic Rankine Cycle Engine (ORCE) for converting solar heat into shaft power is discussed. The efficiency of the system varies from 7-8% for an ORCE heated by low temperature (200 F) flat plate collectors to 25% with high temperature concentrating collectors (300 F). The first solar heated ORCE, built in 1973, produced 3 tons of air conditioning, with the cycle efficiency based on the shaft

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power into the generator estimated at about 7.5%. ORCEs developed for irrigation applications include a 50 hp unit located in Gilla Bend, Arizona, and a 25 hp unit located in Willard, New Mexico, with a design point cycle efficiency at 15%. The current \$150 to \$200 m sq cost of concentrating collectors is estimated to lead to a system cost of over \$2500/kw peak. A.A.

**A79-30542 # Review of liquid piston pumps and their operation with solar energy.** C. L. Murphy (McGill University, Montreal, Canada). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-4.* 8 p. 10 refs. Members, \$1.50; nonmembers, \$3.00.

Liquid piston pumps are considered to be systems involving the up and down oscillations of a fluid column contained in a vessel which is enclosed at the top. At the bottom a suitable arrangement of check valves converts the oscillatory motion to a pumping action. The oscillations may be generated by cyclic heating, inertia forces, or combinations of the two. Existing designs of LPP's are reviewed. Experimental results and a theoretical analysis are given for a straight tube LPP. The design of a solar LPP is presented, which appears to be a practical and simple means of converting heat energy from a solar panel to potential energy of a water reservoir. (Author)

**A79-30543 \* # Do photovoltaics have a future.** B. F. Williams (RCA Laboratories, Princeton, N.J.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-7.* 3 p. 9 refs. Members, \$1.50; nonmembers, \$3.00. Research supported by the RCA Laboratories; Contracts No. E(04-3)-1286; No. JPL-954352.

There is major concern as to the economic practicality of widespread terrestrial use because of the high cost of the photovoltaic arrays themselves. Based on their high efficiency, photovoltaic collectors should be one of the cheapest forms of energy generators known. Present photovoltaic panels are violating the trend of lower costs with increasing efficiency due to their reliance on expensive materials. A medium technology solution should provide electricity competitive with the existing medium to high technology energy generators such as oil, coal, gas, and nuclear fission thermal plants. Programs to reduce the cost of silicon and develop reliable thin film materials have a realistic chance of producing cost effective photovoltaic panels. G.R.

**A79-30544 # Photovoltaic concentrator system technology and applications experiments.** E. L. Burgess (Sandia Laboratories, Albuquerque, N. Mex.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-9.* 11 p. 17 refs. Members, \$1.50; nonmembers, \$3.00. Research supported by the U.S. Department of Energy.

In a flat-panel photovoltaic array a significant portion of the array cost is due to the solar cell cost. The use of concentrated sunlight can increase the output of solar cells and reduce the total cell area required for a given array output. Thus, the concentrator approach is to trade expensive cell area for what is, hopefully, less expensive concentrating optics area. Aspects of photovoltaic concentrator technology development are examined, taking into account silicon solar cells, gallium arsenide solar cells, multi-bandgap solar cells, the adaptation of solar thermal technology, conventional optical designs, and advanced concepts. Photovoltaic concentrator applications experiments are also discussed. G.R.

**A79-30545 # Field tests of photovoltaic power systems.** M. D. Pope and R. W. Matlin (MIT, Lexington, Mass.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-10.* 11 p. 21 refs. Members, \$1.50; nonmembers, \$3.00. Research sponsored by the U.S. Department of Energy.

Field test experience gained at existing photovoltaic test sites is discussed. These sites include a 25-kW peak power system at Mead,

Nebraska, a 12-kW peak array at MIT/Lincoln Laboratory, a 1.5-kW peak PV power system at the Chicago Museum of Science and Industry, and several small (about 100 watts peak) arrays located in various urban and rural sites. Data are given on failures which have occurred in the field and on the frequency of unscheduled outages. Also, information is presented concerning the environmental extremes to which the systems have been exposed. Operating experience gained from these projects is discussed in the contexts of storage, reliability, safety and cost. Finally, some projects which are currently in the design stage are discussed. (Author)

**A79-30546 # Solar photovoltaic power for residential use.** B. Hammond (Motorola, Inc., Phoenix, Ariz.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-11.* 8 p. Members, \$1.50; nonmembers, \$3.00.

A cost analysis is conducted concerning the prospects of solar photovoltaic power for residential use. When photovoltaics reach 50 cents/Wp, they will become competitive with utility power, if utility power is available as a backup. Without utility backup, cost per kWh is approximately one to three times the cost of grid power. As the cost of modules decrease, the balance of system costs become very significant. In particular, voltage regulator, inverter, batteries, and motor generator become a large percentage of the total. The inverter could be eliminated if dc equipment were used. The use of dc equipment, however, will result in higher maintenance costs than ac equipment. Conventional batteries will continue to increase in price about 10% per year. Possibly more economical means of storage will be available by 1989. If so, then the generator could be replaced with additional energy storage. G.R.

**A79-30547 # An overview of photovoltaic power systems.** C. E. Backus (Arizona State University, Tempe, Ariz.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-12.* 9 p. 48 refs. Members, \$1.50; nonmembers, \$3.00.

Photovoltaic power systems are presently being used for a large number of remote or rural applications. These power systems are replacing conventional power sources such as diesel gasoline generators or primary batteries. With the present high cost of solar cells the photovoltaic power system costs are completely dominated by the cost of the solar cell arrays. Since none of the other system components present major problems to low cost systems, essentially all of the U.S. photovoltaic program is directed towards achieving low cost solar cell panels or systems. The three approaches which are being pursued to lower the cost of photovoltaic systems include the production of low cost silicon solar cell arrays, the development of new materials that would lend themselves to low cost, thin-film arrays, and the development of photovoltaic concentration systems. G.R.

**A79-30548 # Unique aspects of terrestrial photovoltaic system design.** Z. C. Putney (Solarex Corp., Rockville, Md.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-14.* 5 p. Members, \$1.50; nonmembers, \$3.00.

The design of terrestrial photovoltaic power systems involves a process of optimization of elements quite different from that employed in conventional power sources. Solar input varies locally and temporally. Efficiency of conversion to electricity is highly dependent upon collector concentration ratio, orientation and tracking capability, and optical and solar cell technologies employed; other variations occur with temperature and changes in reflective and transmissive properties of components. Reliability is dependent upon system complexity and hardware selected. Energy storage needs are a dual function of the fluctuating solar input and load profile, with a substantial range of photovoltaic array size/storage tradeoffs available in designing a stand-alone system. Key aspects to be considered in the design of a photovoltaic power system are discussed in this

paper, with a specific application treated in details as an example of their implementation.

(Author)

**A79-30549 # Low cost thin-film CdS-based solar cells progress and promise.** A. M. Barnett and J. D. Meakin (Delaware University, Newark, Del.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-15.* 10 p. 12 refs. Members, \$1.50; nonmembers, \$3.00.

The application of loss minimization techniques to specific designs of CdS/Cu<sub>2</sub>S thin film photovoltaic solar cells has successfully identified those areas where design changes and the development of new fabrication techniques can lead to improvement in energy conversion efficiency. The successful development of novel fabrication technology has led to the reproducible improvement in direct sunlight, from an original level of 6.8% achieved in December 1975 to 9.15% presently reported. Further application of this loss minimization technique indicates that significant improvements in open-circuit voltage as well as continued improvements in current and fill factor can lead to the development of a CdS/Cu<sub>2</sub>S thin film solar cell with an energy conversion efficiency in excess of 10%. This 10% efficiency should be achieved within one year.

-G.R.

**A79-30550 # Cast semicrystalline silicon for solar cells.** Z. C. Putney (Solarex Corp., Rockville, Md.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-16.* 5 p. 5 refs. Members, \$1.50; nonmembers, \$3.00.

The widespread use of photovoltaics for the generation of electric power depends partly on the availability of low-cost materials for the manufacture of solar cells. One of several solutions proposed for obtaining such a material is concerned with the casting of semicrystalline ingots. It has been demonstrated that cast semicrystalline silicon can be used to produce high efficiency solar cells. Work is now continuing on understanding the characteristics of the inherent grain boundaries, and increasing the already high level of insensitivity to impurities. Upscaling for commercial production is underway, which should prove semicrystalline silicon to be a major source of base material for the solar cell industry within the next two years.

G.R.

**A79-30551 \* # Structural cost optimization of photovoltaic central power station modules and support structure.** P. D. Sutton (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.), W. J. Stolte, and R. O. Marsh (Bechtel National, Inc., San Francisco, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-SOL-17.* 8 p. Members, \$1.50; nonmembers, \$3.00. Research sponsored by the U.S. Department of Energy.

The results of a comprehensive study of photovoltaic module structural support concepts for photovoltaic central power stations and their associated costs are presented. The objective of the study has been the identification of structural cost drivers. Parametric structural design and cost analyses of complete array systems consisting of modules, primary support structures, and foundations were performed. Area related module cost was found to be constant with design, size, and loading. A curved glass module concept was evaluated and found to have the potential to significantly reduce panel structural costs. Conclusions of the study are: array costs do not vary greatly among the designs evaluated; panel and array costs are strongly dependent on design loading; and the best support configuration is load dependent.

(Author)

**A79-30552 # Photovoltaic electric power generation from a utility perspective.** F. R. Goodman, Jr. (Los Angeles Department of Water and Power, Los Angeles, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-18.* 8 p. Members, \$1.50; nonmembers, \$3.00.

The existing technology for photovoltaic energy conversion is described, and the prospects for improving the technology so that photovoltaic conversion becomes viable for utility related applications are discussed. Photovoltaic devices and photovoltaic systems are considered, as are the relevant technical and institutional issues. The integration of large-scale photovoltaic systems into an electric utility's generating mix is taken into account, together with an examination of system reliability and effective capacity. It is concluded that photovoltaic conversion is highly amenable to usage in dispersed generation throughout an urban utility's service territory with minimal aesthetic or other impact on the environment. A.A.

**A79-30554 \* # Benefits of solar/fossil hybrid gas turbine systems.** H. S. Bloomfield (NASA, Lewis Research Center, Cleveland, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-38.* 16 p.

The potential benefits of solar/fossil hybrid gas turbine power systems were assessed. Both retrofit and new systems were considered from the aspects of cost of electricity, fuel conservation, operational mode, technology requirements, and fuels flexibility. Hybrid retrofit (repowering) of existing combustion (simple Brayton cycle) turbines can provide near-term fuel savings and solar experience, while new and advanced recuperated or combined cycle systems may be an attractive fuel saving and economically competitive vehicle to transition from today's gas and oil-fired powerplants to other more abundant fuels.

(Author)

**A79-30555 \* # High-freezing-point fuels used for aviation turbine engines.** R. Friedman (NASA, Lewis Research Center, Cleveland, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-141.* 12 p. 21 refs.

Broadened-specification aviation fuels could be produced from a greater fraction of crude source material with improvements in fuel supply and price. These fuels, particularly those with increased final boiling temperatures, would have higher freezing temperatures than current aviation turbine fuels. The higher-freezing-point fuels can be substituted in the majority of present commercial flights, since temperature data indicate that in-flight fuel temperatures are relatively mild. For the small but significant fraction of commercial flights, where low fuel temperatures make higher freezing-point fuel use unacceptable, adaptations to the fuel or fuel system may be made to accommodate this fuel. Several techniques are discussed. Fuel heating is the most promising concept. One simple system design uses existing heat rejection from the fuel-lubricating oil cooler, another uses an engine-driven generator for electrical heating. Both systems offer advantages that outweigh the obvious penalties.

(Author)

**A79-30595 Chemical studies of stack fly ash from a coal-fired power plant.** D. G. Coles, R. C. Ragaini, J. M. Ondov (California, University, Livermore, Calif.), G. L. Fisher, D. Silberman, and B. A. Prentice (California, University, Davis, Calif.). *Environmental Science and Technology*, vol. 13, Apr. 1979, p. 455-459. 40 refs. Contract No. W-7405-eng-48.

Concentrations of 42 minor and trace elements in four size fractions of stack fly ash from a large Western coal-fired power plant are reported, together with a discussion of their geochemical behavior. Twenty-two elements, including Al, Ca, Ce, Tb, Sc, and Ti, showed little or no enrichment on the smaller fly-ash particles, while in As, Cd, Ga, Mo, Pb, Sb, Se, W, and Zn the enrichment fraction was observed to increase with decreasing particle size. The behavior of the rest (Ba, Be, Co, Cr, Cu, Ni, Sr, U, and V) was found to be intermediate to that of elements in the groups I and II.

A.A.

**A79-30599 # Electromechanical conversion of energy during the deceleration of a piston in a uniform magnetic field (Elektromekhanicheskoe preobrazovaniye energii pri tormozhenii provodnogo poshchina v odnorodnom magnitnom pole).** V. T. Cheremis and A. D. Podol'tsev (Akademii Nauk Ukrainsko SSR, Institut Elektrodinamiki, Kiev, Ukrainian SSR). *Problemy Tekhnicheskoy Kibernetiki*, No. 1, Jan. 1979, p. 103-107.

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*nicheskoi Elektrodinamiki*, no. 67, 1978, p. 108-114. 5 refs. In Russian.

In the present paper, the characteristics of electromechanical energy conversion during impulsive electrodynamic braking of a massive electrically conducting piston in a uniform external magnetic field are analyzed under the assumption of inductive power takeoff to the external resistance or induction circuit. The braking efficiency is assessed, and means of increasing the coefficient of kinetic to electromagnetic energy conversion are discussed. V.P.

**A79-30742 Effects of nonlinear decay of backscattered light on the anomalous reflectivity.** S. J. Karttunen and R. R. E. Salomaa (Technical Research Centre of Finland, Esbo, Finland). *Plasma Physics*, vol. 21, Mar. 1979, p.247-255. 24 refs.

The effects of parametric decay of backscattered light on the anomalous reflectivity caused by stimulated Raman or Brillouin scattering are investigated. The model takes into account five waves: the pump, the backscattered wave and its electromagnetic decay mode, and two electrostatic plasma waves propagating in opposite directions. Two threshold intensities are predicted: above the lower one the parametric generation starts as a three-wave process; once the pump intensity exceeds the secondary threshold the backscattered wave experiences the nonlinear damping and the reflectivity decreases. The reflectivity reaches a saturation value of the reciprocal of the golden mean, about 62%. The total reflection coefficient of the plasma has a maximum value of 65-78% at 7-9 times the instability threshold, depending on the electrostatic noise level.

P.T.H.

**A79-30910 Thermodynamics of the conversion of diluted radiation.** P. T. Landsberg and G. Tonge (Southampton, University, Southampton, England). *Journal of Physics A - Mathematical and General*, vol. 12, Apr. 1979, p. 551-562. 13 refs.

The thermodynamically permitted efficiencies of solar energy conversion are estimated for conversion into work of direct and of diffuse radiation, and of a combination of the two. An 'effective temperature' is introduced into the analysis, the equality of which for the sink and all pumps defines in part an effective equilibrium, a condition which implies that no work can be extracted from the system. Maximum conversion efficiency as a function of the degree of dilution of the radiation in the absorber is calculated and plotted. For a black absorber, the maximum efficiency rises to 0.93 as the radiation becomes more direct. For a gray absorber, the efficiency can range from 60 to 83%. P.T.H.

**A79-30952 # Solar energy via satellites and international cooperation (Energie solaire via satellites et coopération internationale).** J.-L. Magdelenat (McGill University, Montreal, Canada). In: *Annals of air and space law*, Volume 3. Toronto, Carswell Co., Ltd.; Paris, Editions A. Pedone, 1978, p. 467-482. 41 refs. In French.

International public law and certain provisions of space law are needed to resolve legal questions arising from the development and operation of satellite systems producing solar energy. The Satellite Sun Power Station and the ERDA Powersat project are among the systems under consideration. Attention is given to conflicts over the use of the geostationary orbit, and to the concept that technological capability gives a nation the de facto right to put that technology into effect. J.M.B.

**A79-30996 Gasification of raw lignite in the tube-furnace gasifier (Vergasung von Rohbraunkohle im Röhrenofen-Vergaser).** F. H. Franke, K.-J. Klöcker, W. Koch (Rheinische Braunkohlenwerke AG, Cologne, West Germany), and H. Kreusing (Aachen, Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany). *Brennstoff-Wärme-Kraft*, vol. 31, Mar. 1979, p. 85-89. In German. Research supported by the Bundesministerium für Forschung und Technologie.

The viability of the tube-furnace gasifier process is explored. Experimental studies at RWTH-Aachen's technical facilities are

considered, together with a description of the results. The advantages expected from the process in the production of SNG are compared with those of conventional gasifying processes, showing no decisive advantages for the tube-furnace gasifier. A.A.

**A79-30997 Uncoupling of economic growth and energy consumption - A new strategy of energy politics or only a new slogan ('Entkopplung' von Wirtschaftswachstum und Energieverbrauch - Eine neue Strategie der Energiepolitik oder nur ein neues Schlagwort).** M. Horn. *Energiewirtschaftliche Tagesfragen*, vol. 29, Mar. 1979, p. 144-152. 24 refs. In German.

The term 'uncoupling', which has been used by Müller and Stoy (1978) in their study regarding an economic growth without the consumption of additional energy, appears to indicate a certain quasi-mechanical relation between economic growth and energy consumption which can somehow be abolished in the future. The reported investigation shows, however, that the relation between economic growth and energy consumption is considerably more complex and is also significantly more variable than the concept 'uncoupling' would suggest. Attention is given to the methods used for predicting energy consumption, decision predictions with given rates of growth, the factors which determine the energy requirements, and the relation between economic growth and energy consumption according to the result of official energy prognoses.

G.R.

**A79-30998 The economics of electric power generation from wind energy (Wirtschaftlichkeit der Stromerzeugung aus Windenergie).** W. Former and H.-H. Nissen. *Energiewirtschaftliche Tagesfragen*, vol. 29, Mar. 1979, p. 161-166. 7 refs. In German. Research supported by the Bundesministerium für Forschung und Technologie.

A description is presented of the approaches which must be employed in an evaluation of the economic feasibility of utilization of wind energy for electric power generation applications. The assumption is often made that wind in connection with its intermittent nature cannot provide a contribution to the energy supply whose availability can be considered as assured. In such a case an economic operation of wind energy installations is only possible if the annual capital costs of the wind energy systems are less than the annual fuel costs of the thermal power stations which have been replaced by the wind energy installations. Attention is also given to questions regarding a possible contribution of wind energy to the assured power supply and the economical implications of such a contribution.

G.R.

**A79-30999 Production of mechanical energy by thermodynamic conversion of solar energy (Production d'énergie mécanique par la conversion thermodynamique de l'énergie solaire).** F. Pharabod and X. Pouget-Abadie (Électricité de France, Paris, France). (*Société Française des Mécaniciens, Conférence, Paris, France, Dec. 6, 1977.*) *Revue Française de Mécanique*, no. 66, 1978, p. 5-16. In French.

After a review is presented of the basic principles of thermodynamic conversion of solar energy, in which the ideas of the efficiency curve and the isoefficiency curves for determining optimal temperature are discussed, the paper describes several existing engineering projects. These are a pumping system for arid zones, a 300 kW<sub>e</sub> power plant, and a planned 2000 kW solar power plant using a field of 300 heliostats.

P.T.H.

**A79-31000 Thermal energy storage (Le stockage thermique de l'énergie).** M. Coeytaux (Société Caliqua, Paris, France). (*Société Française des Mécaniciens, Conférence, Paris, France, Dec. 6, 1977.*) *Revue Française de Mécanique*, no. 66, 1978, p. 17-19. In French.

The range of materials that can be used for solar energy storage is very large, and the material to be selected depends on the temperature level and type of storage planned. For storage of sensible heat there are available pressurized water, organic fluids, fused salts, liquid metals, and refractory solids. For storage of latent heat there are nitrates, carbonates, sulfates, chlorides, and fluorides.

P.T.H.

**A79-31001** ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978. Conference sponsored by Air Products, Ltd., BOC, Ltd., British Gas Corp., Central Electricity Generating Board, et al. Guildford, Surrey, England, IPC Science and Technology Press, Ltd. (International Cryogenic Engineering Conferences. Volume 7), 1978. 747 p. \$85.80.

The employment of cryogenics in space research is considered along with superconducting magnets, cryostats and systems, superfluid helium, cryogenics in electrical engineering, industrial applications, heat transfer in the rotating frame, refrigeration, biological freezing, flow dynamics, materials properties, heat transfer, superconducting materials preparation, instrumentation, superconducting conductors, and cryogenic technology and superconductivity in controlled fusion. Attention is given to modern problems of stabilization of superconducting systems, laboratory scale superconducting magnets incorporating filamentary niobium tin, superconductivity in electricity supply, and Soviet investigations on pool boiling of cryogenic liquids.

G.R.

**A79-31003** Cryogenic technology and superconductivity in controlled fusion. N. A. Chernoplekov, D. P. Ivanov, V. E. Keilin, D. A. Panov, and I. L. Zотов (Akademiiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). In: ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1978, p. 18-34. 22 refs.

The main trends are discussed regarding research and development work conducted in the area of controlled thermonuclear reaction. One of the key problems in controlled thermonuclear reactions (CTR) is related to the creation of very intense magnetic fields. Developments concerning plasma magnetic confinement systems are considered, taking into account the design of superconducting magnetic systems. It is shown that cryogenics offers also possibilities for solving problems related to fuel production and energy utilization in CTR systems. Attention is given to techniques of refrigeration, the influence of mechanical loads, and the effect of radiation.

G.R.

**A79-31008** Superconductivity in antenna engineering. V. A. Pavliuk, E. F. Krivosheev, M. A. Martynov, V. I. Mikhailov, and M. P. Chetaev (Akademiiia Nauk Ukrainskoi SSR, Fiziko-Tekhnicheskii Institut Nizkikh Temperatur, Kharkov, Ukrainian SSR). In: ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1978, p. 63-68. 8 refs.

A description is presented of advances in antenna engineering which are based on a utilization of the characteristics of superconductivity. New approaches for an optimization of small-size antenna devices are related to an employment of the physical properties of material maintained at low temperatures. Deep cooling with the aid of appropriate cryogenic supply systems appears to provide the only feasible method for a qualitative improvement of the parameters of small-size antennas.

G.R.

**A79-31009** Superconducting magnets - Present status and problems. G. Bronca (Commissariat à l'Energie Atomique, Paris, France). In: ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1978, p. 69-74.

A number of superconducting magnets have been in use for many years now. It has, therefore, been demonstrated that superconducting magnets can be employed efficiently and reliably. However, the number of applications is still not increasing very rapidly. The various applications of superconducting magnets are examined. Attention is given to accelerators and storage rings, bending and focusing elements, large magnets, detectors, high-intensity field magnets, and applications as optical lens components.

G.R.

**A79-31014** Design and development of the US-TESPE toroidal coil. M. O. Hoenig (MIT, Cambridge, Mass.). In: ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1978, p. 156-170. Research sponsored by the U.S. Department of Energy.

The TESPE facility at Karlsruhe in West Germany, is a small compact torus. It consists of six superconducting toroidal coils and includes poloidal field simulation. One of the six TESPE coils is to be replaced with a U.S. built test coil, called US-TESPE. The (German) TESPE toroidal coils are cooled by a stream of liquid helium from a ring cryostat surrounding the toroidal coils. Each coil has its own vacuum tight housing and is surrounded by a vacuum. The superconductor used in the (German) TESPE coils is NbTi. The coils will be operated at 7000 A, will provide an overall current density of 7000 A/sq cm and a maximum environmental field of 7 tesla. The US-TESPE coil is being developed using a Nb3Sn force cooled superconducting cable.

G.R.

**A79-31019** Refrigeration requirements for future superconductive energy related applications. S. W. Van Sciver, M. A. Hilal, G. E. McIntosh, and E. L. Stone (Wisconsin, University, Madison, Wis.). In: ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1978, p. 296-309. 34 refs.

A survey of the refrigeration needs of proposed superconductive energy related technologies is presented. The devices which are considered include: superconductive magnetic energy storage, magnetically confined fusion reactors, superconducting power transmission lines, magnetohydrodynamic units, and superconducting turbine generators. For each system, the cryogenic helium inventory, makeup and refrigeration requirement are discussed. The survey consists of a compilation of estimates from existing system studies and private communications with various workers in the field. A comparison between future and current state-of-the-art refrigeration is included.

(Author)

**A79-31020** The utilization of LH<sub>2</sub> and LNG cold for generation of electric power by a cryogenic-type Stirling engine. K. Oshima, Y. Ishizaki, S. Kamiyama, M. Akiyama (Tokyo, University, Tokyo, Japan), and M. Okuda (Tokyo Gas Co., Ltd., Tokyo, Japan). In: ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978.

Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1978, p. 310-317. 6 refs. Research supported by the Iwatai Naaji Foundation.

In a regasification process for LNG and LH<sub>2</sub>, a cryogenic-type Stirling engine combined with an electric generator is used as the main component. This engine is cooled by LNG or LH<sub>2</sub> and is heated by hot water rejected from the power station, so that the engine runs and supplies additional electric power together with fuel gas supplied at room temperature. A regasification process supplying LH<sub>2</sub> and LNG for a 1,000 MW power station has been designed. Results of a successful test made on a small cryogenic-type Stirling engine are described.

(Author)

**A79-31086** Direct conversion of solar energy into laser radiation. A. L. Golger, L. I. Gudzenko, and S. I. Iakovlenko (Akademiiia Nauk SSSR, Fizicheskii Institut and Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). (*Kvantovaya Elektronika /Moscow/*, vol. 5, Sept. 1978, p. 1982-1989.) *Soviet Journal of Quantum Electronics*, vol. 8, Sept. 1978, p. 1118-1122. 14 refs. Translation.

The possibility of converting solar energy into laser radiation is

## A79-31098

discussed for a mixture of xenon and cesium vapor as the active medium. Estimates show that using a 20-fold solar radiation concentrator it should be possible to achieve CS stimulated emission at 1358.9 and 1469.5 nm with a conversion efficiency of about 3.5%. For an active medium about 25 m long and having a transverse cross section of about 0.4 x 0.1 m, the laser power will be about 7 kW. (Author)

## A79-31098 Thermoelectric magnetohydrodynamics. J. A. Shercliff (Warwick, University, Coventry, England). *Journal of Fluid Mechanics*, vol. 91, Mar. 23, 1979, p. 231-251. 25 refs.

The reported investigation is concerned with the establishment of the equations of magnetohydrodynamics and thermal convection when coupled by thermoelectricity. Some illustrative problems in which the thermal field is known ab initio are solved. Examples where the effects are due to either continuous or discontinuous variation of material composition are included. Practical magnitudes are discussed for the case of a fusion-reactor blanket, where the effects are potentially important owing to the unusual thermoelectric power of lithium. G.R.

## A79-31099 Two-dimensional analyses related to wave-energy extraction by submerged resonant ducts. J. Lighthill (Cambridge University, Cambridge, England). *Journal of Fluid Mechanics*, vol. 91, Mar. 23, 1979, p. 253-317. 14 refs.

It is pointed out that submerged resonant ducts offer an approach to the design of wave-energy extraction devices consistent with the need for maximum seaworthiness. A full account is provided of one type of analysis of these systems, based upon two-dimensional wave hydrodynamics and linearized duct dynamics. One theoretical prediction is that the effective pressure fluctuations to which a resonant duct responds can be substantially greater than those that would be present at the level of the duct mouth if the duct were absent. Other important predictions are concerned with added mass, radiation damping, and the conditions for optimum energy extraction. G.R.

## A79-31121 # Advanced air transport concepts. J. K. Mollon (NASA, Langley Research Center, Aeronautical System Div., Hampton, Va.). *AIAA Student Journal*, vol. 17, Spring 1979, p. 12-16. 6 refs.

The concepts of laminar flow control, very large all-wing aircraft, an aerial relay transportation system and alternative fuels, which would enable large improvements in fuel conservation in air transportation in the 1990's are discussed. Laminar boundary layer control through suction would greatly reduce skin friction and has been reported to reduce fuel consumption by up to 29%. Distributed load aircraft, in which all fuel and payload are carried in the wing and the fuselage is absent, permit the use of lighter construction materials and the elimination of fuselage and tail drag. Spanloader aircraft with laminar flow control could be used in an aerial relay transportation system which would employ a network of continuously flying liners supplied with fuel, cargo and crews by smaller feeder aircraft. Liquid hydrogen and methane fuels derived from coal are shown to be more weight efficient and less costly than coal-derived synthetic jet fuels. A.L.W.

## A79-31146 # Biological conversion of solar energy (Biologicheskoe preobrazovanie solnechnoi energii). A. A. Krasnovskii. *Akademii Nauk SSSR, Vestnik*, no. 1, 1979, p. 83-96. 17 refs. In Russian.

Some topics on biological conversion of solar energy are touched upon, including the molecular mechanism of photosynthesis, the photochemistry of chlorophyll, the mechanism of photosynthesis of hydrogen by water organism cells, and the transfer of electrons in reactions centers of photosynthesizing bacteria. It is pointed out that the limiting efficiency of photosynthesis processes is 15%, while silicon solar batteries in spacecraft can use up to 20% of the solar radiation. P.T.H.

## A79-31153 A new thermochemical process for hydrogen production. B. Lecart, M. Devalette, J. P. Manaud, G. Meunier, and P. Hagenmuller (CNRS, Laboratoire de Chimie du Solide, Talence, Gironde, France). *International Journal of Hydrogen Energy*, vol. 4, no. 1, 1979, p. 7-11.

A novel water decomposition cycle with several reactions, some of which using a solvent, is described. Such a process makes it possible to lower the maximum temperature of the endothermic reactions, and the increase in the required amount of heat does not appreciably affect the thermal efficiency. The decomposition of water into hydrogen and oxygen is carried out by means of redox couples  $\text{Ag}(+)/\text{Ag}(\text{O})$  and  $\text{Cu}(2+)/\text{Cu}(+)$ . The water-splitting cycle involves four main reaction steps. Experimental results are found to be in good agreement with thermodynamic calculations. A thermal efficiency of about 41% is obtained at a maximum temperature of 570 C. S.D.

## A79-31154 Direct thermomagnetic splitting of water. R. L. Curl (Michigan, University, Ann Arbor, Mich.). *International Journal of Hydrogen Energy*, vol. 4, no. 1, 1979, p. 13-20. 14 refs. Research supported by the Organization Control Services, Inc.

The application of a magnetic field to water tends to cause its decomposition into hydrogen and oxygen. Based upon the thermomagnetochimistry of the phenomenon, a process is suggested for carrying out the reaction and separating the product hydrogen and oxygen. The process would have nearly Carnot efficiency, although the requisite magnetic field (about 10,000 tesla) is not at present attainable. (Author)

## A79-31156 Hydrogen storage in FeTi - Surface segregation and its catalytic effect on hydrogenation and structural studies by means of neutron diffraction. G. Busch, L. Schlapbach, F. Stucki (Eidgenössische Technische Hochschule, Zurich, Switzerland), P. Fischer (Eidgenössische Technische Hochschule, Würenlingen, Switzerland), and A. F. Andresen (Institutt for Atomenergi, Kjeller, Norway). *International Journal of Hydrogen Energy*, vol. 4, no. 1, 1979, p. 29-39. 19 refs. Research supported by the Swiss National Science Foundation.

## A79-31183 The contribution of plasma dielectric properties to the cyclotron radiation spectrum from a tokamak plasma. C. M. Celata and D. A. Boyd (Maryland, University, College Park, Md.). *Nuclear Fusion*, vol. 19, Apr. 1979, p. 423-441. 13 refs. Research supported by the U.S. Department of Energy and NSF.

The effects of the dielectric properties of the plasma on the cyclotron radiation spectrum from a tokamak discharge are investigated for propagation perpendicular to the magnetic field. At the cutoffs and at the upper-hybrid resonance the cold-plasma dispersion relation is assumed to be valid. It is shown that the presence of evanescent regions, cutoff surfaces, and an upper-hybrid resonance surface in the plasma distorts the line shape at the lower harmonics when plasma and cyclotron frequencies are of the same order. The first-harmonic extraordinary-mode emission is suppressed as the plasma/cyclotron frequency ratio at the center of the discharge increases owing to decoupling of the electromagnetic wave from the plasma electrons. A computer study is made of the changes in the spectrum as the plasma/cyclotron frequency ratio at the center of the discharge is increased. The anisotropy of the cyclotron radiation spectrum about the minor axis of the torus is also investigated. Both line width and shape depend on the viewing direction. (Author)

## A79-31184 Radial transport in the ELMO Bumpy Torus in collisional regimes. E. F. Jaeger and C. L. Hedrick, Jr. (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *Nuclear Fusion*, vol. 19, Apr. 1979, p. 443-453. 18 refs. Contract No. W-7405-eng-26.

Neutral and charged-particle densities and temperatures are calculated as functions of radius for the toroidal plasma in the ELMO Bumpy Torus (EBT). Energy-dependent ionization and charge exchange rates, ambipolar diffusion, and self-consistent radial electric-field profiles are included. Variations in the magnetic field

due to finite toroidal plasma pressure and transport due to drift waves and magnetic-field errors are neglected. When the large electric-field limit of the neoclassical transport coefficients is used, results are limited to relatively cool electrons (electron kinetic energy about 100-200 eV) and collisional scaling for radially inward-pointing electric fields. (Author)

**A79-31185 Interpretation of cyclotron radiation spectra from runaway discharges in TFR.** S. Tamor (Science Applications, Inc., La Jolla, Calif.). *Nuclear Fusion*, vol. 19, Apr. 1979, p. 455-460. 18 refs. Contract No. EY-76-C-03-1018.

The cyclotron radiation spectra from runaway tokamak discharges are discussed and numerical studies reported which attempt to fit the observed data with simple model distribution functions. A model is exhibited which is both physically reasonable and in qualitative agreement with experiment. A tentative attempt is made to compare this result with the theory for runaway dynamics of Parail and Pogutse. It is found that a consistent picture can be formulated if some assumptions are made concerning initial breakdown conditions. (Author)

**A79-31186 A ray-tracing analysis of fast-wave heating of tokamaks.** B. D. McVey (Wisconsin University, Madison, Wis.). *Nuclear Fusion*, vol. 19, Apr. 1979, p. 461-468. 20 refs. NSF Grant No. ENG-75-19259.

The complete linear hot-plasma dispersion relation, derived from kinetic theory is numerically solved for the ion cyclotron range of frequencies. A compact dispersion relation is obtained which is an accurate approximation for both fast and ion Bernstein waves. With the help of this dispersion relation, the three-dimensional ray equations for a tokamak geometry are solved, parabolic density and temperature profiles, the 1/R variation in the toroidal magnetic field, and the resulting poloidal magnetic field due to a rotational transform being incorporated. The ray-tracing analysis is applied to a conceptual design tokamak reactor. The results indicate the nature of the scaling of fast-wave heating to large tokamaks. (Author)

**A79-31188 The effects of wall temperature on light impurities in Alcator.** E. S. Marmar, D. Overskei, H. Helava (MIT, Cambridge, Mass.), K. I. Chen, J. L. Terry, and H. W. Moos (Johns Hopkins University, Baltimore, Md.). *Nuclear Fusion*, vol. 19, Apr. 1979, p. 485-488. 9 refs. Contracts No. ET-78-C-01-3019; No. EY-76-S-02-2711.

The effects of wall temperature on light impurity concentrations in the Alcator tokamak were measured spectroscopically. The results show that the temperature reduction decreases the influx of oxygen by a factor of 4-5 in normal tokamak operation when the wall temperature dropped from 450 to 77 K but does not affect the other light impurities (N, C). (Author)

**A79-31189 MHD stability of Spheromak.** M. N. Rosenbluth (Institute for Advanced Study, Princeton, N.J.) and M. N. Bussac (Institute for Advanced Study, Princeton, N.J.; Ecole Polytechnique, Palaiseau, Essonne, France). *Nuclear Fusion*, vol. 19, Apr. 1979, p. 489-498. 13 refs. Contract No. EY-76-S-02-3237.

The 'Spheromak', an optimal force-free spherical plasma configuration, is analysed for its MHD stability properties. It is shown that flattened ellipse (oblimak) with the current-density vector equal to the magnetic-field vector times a position-independent constant should be stable against all magnetically driven MHD and resistive tearing modes if surrounded by a conducting wall at about 1.15 times the radius of the sphere. Betas of at least 2% can be stably confined, equivalent to 20% in tokamaks. (Author)

**A79-31192 MHD gas turbine energy conversion for mirror fusion reactors.** S. Shioda and K. Maeda (Tokyo Institute of Technology, Tokyo, Japan). *Nuclear Fusion*, vol. 19, Apr. 1979, p. 508-514. 12 refs.

An MHD gas turbine energy conversion system for mirror fusion reactors is proposed. An inert-gas working fluid, which has been heated in the blanket, is super-heated in a plasma thermalizer up to

2800-3000 K, where the charged-particle energy from the open ends of a mirror and from neutral-beam injectors is thermalized. Overall-efficiency calculations show that the MHD gas turbine system shows great potentialities for overall-efficiency increase as well as for a reduction in the capital cost of a mirror reactor conversion system, and that the overall efficiency of the MHD gas turbine system becomes larger than that of the electrostatic Venetian-blind-direct energy convertor system with a steam-turbine bottoming cycle when the reactor blanket outlet temperature is higher than 1300 K. (Author)

**A79-31193 Large tokamak experiments - Report on the Third IAEA Technical Committee Meeting, Paris, 1-6 September 1978.** B. J. Green. *Nuclear Fusion*, vol. 19, Apr. 1979, p. 515-534. 9 refs.

Progress reports on large tokamak experiments presently under construction are summarized. The status of the tokamak program is discussed, along with outstanding problems in achieving controlled fusion and technical aspects of the TFTR, JET, JT-60, and T-10 M devices. The future program in tokamak research is outlined. Specific attention is given to recent advances in plasma heating and confinement, divertor operation, thermal energy transport, long-discharge operation of tokamaks, plasma diagnostics, magnet systems for large tokamaks, power supplies, shielding, maintenance, design considerations for true fusion reactors, vacuum systems, control and data acquisition systems, superconducting-coil tokamaks, and divertor tokamaks. F.G.M.

**A79-31315 Case history - Hybrid passive/active solar system: Performance and cost.** B. D. Hunn (California University, Los Alamos, N. Mex.). (*American Society of Heating, Refrigerating and Air-Conditioning Engineers, Symposium on Passive Solar Systems, Philadelphia, Pa., Jan. 28-Feb. 1, 1979.*) *ASHRAE Journal*, vol. 21, Apr. 1979, p. 25-30.

The design, construction, cost, and initial operation of a hybrid passive/active solar-heated house in Los Alamos, NM, is described. In the active mode, a blower circulates air through the Trombe (thermal storage) wall air space and into a rock bed with a 3-zone forced air distribution system connected to it. A separate flat-plate collector array heats a preheater tank for domestic hot water. Energy consumption records indicate that about 60% of the net space heating load was provided by solar energy. A.A.

**A79-31316 Heat pump design - Cost effectiveness in the collection, storage and distribution of solar energy.** J. G. Cottingham (Brookhaven National Laboratory, Upton, N.Y.). (*American Society of Heating, Refrigerating and Air-Conditioning Engineers, Symposium on Solar-Assisted Heat Pumps, Philadelphia, Pa., Jan. 28-Feb. 1, 1979.*) *ASHRAE Journal*, vol. 21, Apr. 1979, p. 35-38. 11 refs. Research sponsored by the U.S. Department of Energy.

**A79-31347 Effects of minority-carrier storage at the interface states on the fill factor of m.i.s. solar cells.** O. M. Nielsen (Danmarks Tekniske Højskole, Lyngby, Denmark). *IEE Journal on Solid-State and Electron Devices*, vol. 3, Mar. 1979, p. 51-55. 15 refs.

Current-voltage characteristics obtained under dark and illuminated conditions have been examined for Al-p-Si MIS solar cells. The results obtained show that the voltage across the cells taken at the maximum-power point is typically 50 mV smaller when the cells are illuminated compared to the voltage at the same point in darkness. This is explained as an increase in the recombination current and as an increased concentration of minority carriers at the interface states of about 10 trillion/sq cm when going from dark to illuminated conditions. The result is that the fill factor obtained from the illuminated characteristic is about 9% smaller than if the fill factor is calculated from the dark characteristics. (Author)

**A79-31351 Fiat Research Center hybrid vehicle prototype.** L. Morello, R. Piccolo, and L. Ippolito (Fiat S.p.A., Turin,

## A79-31352

Italy). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790014.* 11 p. 7 refs.

Mathematical models to evaluate the energy consumption of hybrid propulsion systems are presented, and road tests of a prototype hybrid propulsion vehicle are reported. The mathematical model incorporates several component analyses, including a thermal engine represented by a fuel consumption map, an efficiency map for a compound dc electric machine, a simulation of normal battery operation, a transmission system model, and clutch and torque converter models. A modular computerized version of the mathematical models provides a flexible instrument for analyzing a number of hybrid propulsion systems. Analysis of a prototype hybrid propulsion vehicle indicates fuel savings of about 18% with respect to conventional traction vehicles. J.M.B.

**A79-31352** Efficiency studies about Daihatsu engine/electric hybrid system. S. Honda, C. Hoshino, S. Kawakatsu, H. Tsukano, T. Yamamoto, and M. Iida (Daihatsu Motor Co., Ltd. Japan). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790013.* 18 p.

Computer simulation is adopted to study the efficiency of a 1.5-ton engine/electric hybrid truck. The truck design provides four driving modes: engine driving, engine driving with recharging, engine and electric driving, and electric driving. Fuel consumption under various driving modes is discussed. J.M.B.

**A79-31355** Air bearing development for a GM automotive gas turbine. R. J. Trippett (GM Research Laboratories, Warren, Mich.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790107.* 11 p. 12 refs. Research supported by the General Motors Corp.

Elimination of oil from the hot section of the engine, very low running losses, and potential cost reductions are incentives to develop air bearings for the high speed rotors of automotive gas turbines. Low air bearing stiffness, start-stop wear, and high starting torque are design challenges in this application. This paper outlines analytical and experimental programs devised to evaluate air bearing usage in vehicular gas turbines. Air bearing operation has been demonstrated in engine dynamometer tests. A better understanding of the many factors which affect the performance of cantilevered-leaf air bearings has been realized through extensive rotor dynamics rig testing coupled with development of bearing analysis computer programs. Measured running losses of the air bearing are much lower than those of the oil jet lubricated ball bearing it is replacing. Increasing leaf thickness, leaf-housing attachment angle, leaf free radius and eliminating the clearance between the leaf beam and housing slot increased the bearing stiffness. (Author)

**A79-31356 \*** Foil type bearings for the Chrysler Automotive Gas Turbine Engine Program - Development and operational experiences. S. Gray (Mechanical Technology, Inc., Latham, N.Y.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790109.* 19 p. 8 refs. Research supported by the U.S. Department of Energy and NASA.

**A79-31357** EPRI/TVA pilot electric vehicle demonstration program. R. J. Ferraro (Electric Power Research Institute, Palo Alto, Calif.) and D. L. Harbaugh (Southern California Edison Co., Los Angeles, Calif.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790110.* 9 p.

The considered program is mainly concerned with the identification of the potential interactions between large-scale use of electric vehicles (EVs) and utility operations. By combining reliable EVs with present day state-of-the-art data collection technology the two year pilot demonstration will establish the characteristics and capabilities of EVs in a representative operating environment within the electric utility industry. The key requirements for an EV support infrastructure are to be established for viable, larger-scale demonstration programs. Other objectives are related to the identification of optimum ways for the electric utility industry to participate in

larger-scale demonstration programs, and the identification of high priority areas of research, design, and development for EVs. G.R.

**A79-31358** The London Electric Delivery Van Assessment Scheme. G. W. Wicken (Department of Industry, Vehicles Div., London, England). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790111.* 13 p. 15 refs.

The performance, reliability and maintenance and running costs of 62 battery electric delivery vans, supplied by three manufacturers, in daily use in the Greater London area are being assessed over a three year period in comparison with closely equivalent conventional vehicles on similar duties. The primary purpose is to obtain independent operational experience covering a wide variety of suitable applications over an extended period and provide reliable factual information about the performance of the vehicles in normal daily use with typical loads and drivers. Information of value to operators, the industry and Government will be produced. (Author)

**A79-31360** Some design considerations of automotive gas turbines. R. A. Mercure (U.S. Department of Energy, Div. of Transportation Energy Conservation, Washington, D.C.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790128.* 10 p. 10 refs.

The development of the gas turbine engine as a possible alternative to the spark-ignition and compression-ignition engines has been considered in connection with objectives related to the reduction of fuel consumption and environmental considerations. Efforts directed towards the development of a gas engine for the automobile during the last 30 years have, however, failed to produce a satisfactory engine. The reported investigation is concerned with the problems that remain to be solved particularly in regard to the design and manufacturing areas. A cursory examination on the benefits of increasing cycle temperature is made. Possible solutions to these problems are then suggested as areas for concentration of future research and development efforts. G.R.

**A79-31361** Field experience with the Detroit Diesel Allison 404/505 industrial gas turbine engines. E. E. Flanigan and D. N. Nigro (General Motors Corp., Detroit Diesel Allison Div., Detroit, Mich.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790129.* 27 p.

Detroit Diesel Allison Division of General Motors Corporation conducted a field evaluation program on the 300 hp GT-404-3 and the 390 hp GT-505-3 industrial gas turbine engines. The overall program plan, involving installations in trucks, coaches, marine and industrial applications, as well as the field experience accumulated to date, are discussed. Two particular applications are explored in detail: the bulk hauling trucks with self unloading capabilities, and the Greyhound inter-city coach operation with gas turbine power and automatic transmissions. The gas turbine engines were shown to have performed well in all the encountered applications, especially in the bulk unloading and Greyhound cases. Performance of heavy trucks and coaches on ice was found to be superior to anything on the road both during engine braking and starting on hills. A.A.

**A79-31363** Electric vehicle battery development. C. W. Fleischmann (Eltra Corp., Electric Vehicle Group, Plymouth Meeting, Pa.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790158.* 11 p. 32 refs. ERDA Contracts No. 31-109-38-3628; No. 31-109-38-4206.

A description is presented of the development of a new lead-acid battery for electric vehicle propulsion applications. The battery which is being developed uses expanded metal, nonantimonial alloy grids, enveloped separation/retention, and high-rate production methods of packaging including through-the-wall construction. The battery is expected to meet the Department of Energy goals for the improved state-of-the-art electric vehicle battery and to be further improved to meet the Department of Energy goals for the advanced battery. G.R.

**A79-31366** Thermal management of the lithium/metal sulfide electric vehicle. M. M. Farahat, J. A. E. Graae, A. A. Chilenskas, and D. L. Barney (Argonne National Laboratory, Argonne, Ill.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790161.* 7 p.

Thermal management studies of the lithium-aluminum/metal sulfide battery have indicated the need for a light-weight high thermal efficiency case for electric batteries. Calculations based upon the rectangular configured MK IIA battery using vacuum-foil insulation, show that the heat loss rate goal of 400 W can be met. Experimental studies directed at the determination of the reversible heating gave results that compared within 8% with theoretically derived values. Calculations based upon the 50-kWh MK II battery and a 10,000 miles driven/year show that by utilizing the thermal storage capacity of the system, essentially no additional energy is needed to keep the battery hot. (Author)

**A79-31367** A high energy tubular battery for a 1800 kg payload electric delivery van. M. L. Whitehead (Chloride Technical, Ltd., England). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790162.* 10 p.

A high energy lead-acid battery was developed to provide, at no extra cost, a 1800 kg (4000 lb) payload electric delivery van with a driving range of 80 - 90 km (50 to 55 miles). In addition to the new high performance electrodes, an integrated approach to the total power source concept evolved new lightweight designs for battery packaging, a system-engineered battery charger, and an automatic topping-up facility. Despite the 40% improvement in range, as compared to 55 - 65 km (35 - 40 miles) for conventional traction batteries, a 4 year battery life is expected due to the reinforcing features of the tubular design adopted for the positive electrode. (Author)

**A79-31368 \*** Initial comparison of single cylinder Stirling engine computer model predictions with test results. R. C. Tew, Jr., L. G. Thieme, and D. Miao (NASA, Lewis Research Center, Cleveland, Ohio). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790327.* 18 p. 15 refs.

A NASA developed digital computer code for a Stirling engine, modelling the performance of a single cylinder rhombic drive ground performance unit (GPU), is presented and its predictions are compared to test results. The GPU engine incorporates eight regenerator/cooler units and the engine working space is modelled by thirteen control volumes. The model calculates indicated power and efficiency for a given engine speed, mean pressure, heater and expansion space metal temperatures and cooler water inlet temperature and flow rate. Comparison of predicted and observed powers implies that the reference pressure drop calculations underestimate actual pressure drop, possibly due to oil contamination in the regenerator/cooler units, methane contamination in the working gas or the underestimation of mechanical loss. For a working gas of hydrogen, the predicted values of brake power are from 0 to 6% higher than experimental values, and brake efficiency is 6 to 16% higher, while for helium the predicted brake power and efficiency are 2 to 15% higher than the experimental. A.L.W.

**A79-31369** An air/fuel control system for the Stirling engine. J. E. Fenton (Ford Motor Co., Detroit, Mich.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790328.* 7 p. Contract No. EC-77-C-02-4396.

An air/fuel control system has been developed for the Stirling engine, which derives power from its continuous external combustion process. The repeatable air/fuel control system provides a wide range of metered fuel flows and adjustable air/fuel ratios, necessary features for the mapping and optimization of Stirling engine components. The control system includes control of the fuel flow and combustion air flow, measurement of the combustion air flow and the hydrogen temperature at the heater head, and control of the exhaust gas recirculation. J.M.B.

**A79-31370** The Stirling engine for automotive application. K. Rosengqvist, T. Lia (United Stirling of Sweden, Malmo, Sweden), and B. Goldwater (Mechanical Technology, Inc., Latham, N.Y.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790329.* 15 p. 7 refs.

A program for the development of a Stirling engine for automotive passenger car applications was initiated by a Swedish and a U.S. company. The engine is to be based on a 4-cylinder, double acting, crank driven design that is being developed in Sweden since 1968. Derivatives of this engine design have been considered for many other applications, including stationary power generator systems, truck propulsion, underground mining power systems, heat pumps, and solar engines. A description is provided of the general state of Stirling engine technology that exists at the two companies. After initial development work, the Stirling engines are now being considered as an alternative power plant for automotive application. Although it has been claimed by industry that the Stirling engine is bulky and heavy, the recent concept of design has decreased weight and manufacturing cost significantly which makes it commercially attractive for medium duty application. G.R.

**A79-31371** A one-dimensional combustion model for a dual chamber stratified charge spark ignition engine. S. C. Sorenson and S. S. Pan (Illinois, University, Urbana, Ill.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790355.* 19 p. 33 refs.

A model has been developed for simulating the combustion in a three-valve stratified charge spark ignition engine. The conservation equations for mass, momentum, chemical species, and energy are numerically integrated for a one-dimensional flame using an empirical model for turbulent diffusivity. The chemical reaction of the fuel and air is modeled using simple kinetics in a one-step reaction and experimentally determined ignition delays are used. Nitric oxide emissions are calculated using a simple Zeldovich model with steady state atomic nitrogen and equilibrium atomic oxygen. Effects of various assumptions and parameters in the model are discussed and comparisons with experimental data from a single-cylinder engine are presented. (Author)

**A79-31374** Emissions and economy potential of pre-chamber stratified charge engines. D. L. Dimick, S. L. Genslak, R. E. Greib, and M. J. Malik (General Motors Corp., Detroit, Mich.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790436.* 17 p. 6 refs.

Research investigation on the potential of prechamber stratified charge engines as alternatives to conventional engines is reviewed. A single-cylinder engine study is taken into account, as is design and development of two multicylinder engines incorporating prechamber 3-valve configurations. A car development and evaluation program using both small and large cars with alternative engine configurations and aftertreatment devices, is outlined. It is concluded that the prechamber stratified charge engines possess NO<sub>x</sub> emission and fuel economy performance similar to a conventional engine but at a high HC emission level. A.A.

**A79-31375** The influence of overall equivalence ratio and degree of stratification on the fuel consumption and emissions of a prechamber, stratified-charge engine. J. F. Sinnamon (GM Research Laboratories, Warren, Mich.) and D. E. Cole (Michigan, University, Ann Arbor, Mich.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790438.* 19 p. 25 refs. NSF-supported research.

An experimental study of a divided-chamber, stratified-charge engine was made using a modified CFR L-head engine. Emissions and fuel consumption were measured over a wide range of overall fuel-air ratio and degree of stratification by varying the prechamber and main chamber inlet fuel-air ratios. Trends in the emissions data were evaluated by analyzing the combustion process and the spatial distribution of fuel-air ratio in the combustion chamber or measured by a sampling valve. It was found that NO<sub>x</sub> emissions increase with increasing degree of stratification at lean overall fuel-air ratios. A.A.

**A79-31376 A new combustion system in the three-valve stratified charge engine.** S. Yagi, I. Fujii, M. Nishikawa, and H. Shirai (Honda Research and Development Co., Ltd., Tokyo, Japan). In: *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790439*. 10 p.

The branched conduit combustion system has been developed to reduce exhaust emissions from the three valve stratified charge automobile engine. The system consists of a main combustion chamber, similar to that of the original stratified charge engine, connected to an auxiliary combustion chamber by a long tapered torch passage, from which other passages (branched conduits) branch out and open into the main combustion chamber. Tests show that hydrocarbon and NO<sub>x</sub> emissions in the branched conduit engine are 20% lower than in the conventional stratified charge engine, and exhaust gas temperature is 30 C higher. High speed photographs of combustion processes show that combustion terminates later in the branched conduit engine and is more stable, indicating that the branched conduits allow unburnt gases to recirculate. A taper angle of the torch passage of 10 degrees and the existence of three branched conduits are shown to minimize hydrocarbon emissions, and the location of the branch point is also shown to have an effect.

A.L.W.

**A79-31401 Renewable alternatives; Proceedings of the Fourth Annual Conference, University of Western Ontario, London, Canada, August 20-24, 1978. Volumes 1 & 2.** Conference sponsored by the Solar Energy Society of Canada, Ministry of Energy, Mines and Resources, National Research Council of Canada, et al. Winnipeg, Solar Energy Society of Canada, Inc., 1978. Vol. 1, 731 p.; vol. 2, 277 p. In English and French. Price of two volumes, \$29.47.

Flat plate collectors are discussed, taking into account new approaches regarding the ranking and evaluation of flat plate collectors, the optimization of the flow passage geometry for air heating solar collectors, the performance analysis of a flat plate solar collector using 'forge-fin' tubes, an energy analysis of an aluminum solar collector, the dimensional relations for free convective heat transfer in flat plate collectors, optimization studies on black chrome electroplating variables for solar selective surfaces, and the application of the honeycomb heat trap in flat plate solar collectors. Attention is also given to concentrators, aspects of heat storage, photochemistry and photovoltaics, testing, radiation measurement, the utilization of the ocean temperature difference, monitoring and performance reports, biomass energy, wind energy, economics, energy policy, solar heating, solar domestic hot water, simulation, controls, the heat pump, solar cooling, life styles, conservation, and passive heating.

G.R.

**A79-31402 Ranking and evaluation of flat-plate collectors - Two new approaches.** J. H. White (Dilworth, Secord, Meagher and Associates, Ltd., Toronto, Canada). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1*. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p.

An index format is developed which will allow ready ranking of a collector's ability to deliver heat to a seasonal-storage system. It is location sensitive but not configuration sensitive. There are indications that the index could also be applicable to short storage systems and be developed further into a system design tool. When used in conjunction with a reference system which presents the optimum efficiency in terms of a number of 'equivalent reflections' and an 'equivalent resistance' concept, it is possible to see that single-glazed collectors, to date, are quite restricted in their ability to deliver heat, while some antireflective double-glazed collectors with selective coatings have established double the index margins and therefore almost double the heat delivering capability when used in seasonal-storage systems.

G.R.

**A79-31403 Optimization of the flow passage geometry for air heating solar collectors.** E. C. Shewen and K. G. T. Hollands (Waterloo, University, Waterloo, Ontario, Canada). In: *Renewable*

alternatives; *Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1*. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 9 refs. Department of Supply and Services Contract No. 12SQ-31155-7-4409.

The flow passage geometry for air heating solar collectors of the underflow type has been examined from the point of view of maximizing the collector efficiency for a specific pressure drop. Parameters studied include the absorber to air stream heat transfer coefficient, the flow passage dimensions, the pressure drop and the air flow rate. A generalized study of improving the heat transfer coefficient for a specified pressure drop is presented. This study has led to a novel air heater design referred to as the 'short path concept'. (Author)

**A79-31404 Performance analysis of a flat-plate solar collector using 'forge-fin' tubes.** K. F. Schenk, C. R. Dua, and J. T. Munoz (Ottawa, University, Ottawa, Canada). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1*. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 14 p. 9 refs. Research supported by the National Research Council of Canada.

An analysis is conducted of a flat-plate solar collector utilizing internally finned tubes to obtain its thermal performance. These 'forge-fin' tubes enhance the heat transfer between fluid and absorbing plate. A solar test facility was built and the collector efficiency obtained. It was found that the efficiency of the proposed collector using internally finned tubes is about 10% higher than that of a conventional type of flat-plate collector under similar outdoor conditions. It had been pointed out by Watkinson et al. (1974) that 2 feet of 'forge-fin' tube was equivalent to 8 feet of smooth tube in heat exchangers due to its augmented heat transfer properties. After evaluation of the performance of the proposed flat-plate solar collector using these tubes, an improvement has been noticed over that of a collector using smooth tubes. However, 'forge-fin' tubes are more expensive than conventional smooth tubes and this increases the cost per unit area of the proposed collector.

G.R.

**A79-31405 Energy analysis of an aluminum solar collector.** W. Ashton and J. E. Robinson (Waterloo, University, Waterloo, Ontario, Canada). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1*. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 9 p. 20 refs.

An analysis was conducted of the energy consumption involved in an installation of aluminum solar collectors to ascertain the length of time which would be required to recover the energy invested in manufacture. It was found that approximately four years of operation will be required to regain the energy consumed in the manufacture of the solar collector system from raw materials. It was also found that the use of recycled metal substantially reduces the energy pay-back period to just over one year. In this case, then, the energy viability of one new technology, a solar collector system, is enhanced significantly by parallel developments in others such as metal recycling.

G.R.

**A79-31406 Dimensional relations for free convective heat transfer in flat-plate collectors.** K. G. T. Hollands (Waterloo, University, Waterloo, Ontario, Canada). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1*. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 11 refs. Research supported by the U.S. Department of Energy.

Free convection heat transfer is one of the dominant modes of heat loss in a flat plate solar collector. Recently there have been reported new data and correlation equations for free convective heat transfer in various geometries similar to those found in solar collectors. In most of this work, the results have been reported in terms of dimensionless groups. This method of presentation does not immediately indicate how the results may be used for design decisions on collectors. A description is presented of the new results in terms of dimensional equations and graphs, thereby pointing the

way to improved design techniques. Particular emphasis is placed on the new free convective information resulting from studies carried out at the University of Waterloo.

G.R.

**A79-31407 Optimization studies on black chrome electroplating variables for solar selective surfaces.** A. R. Balakrishnan, K. G. T. Hollands, E. C. Shewen, and P. Niessen (Waterloo, University, Waterloo, Ontario, Canada). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1.* Winnipeg, Solar Energy Society of Canada, Inc., 1978. 11 p.

Winnipeg, Solar Energy

A description is given of the results of a study whose object was to identify and optimize the variables involved in obtaining a black chrome coating that has as high a short wave absorptivity and as low a long wave emissivity as possible. In addition humidity testing was performed to get a qualitative measure of the durability of these surfaces. Substantial differences were observed between the characteristics of the black chrome versions of two U.S. manufacturers. It was found that the bath temperature influences the behavior of the electroplating process. Black chrome on nickel plate steel exhibits excellent resistance to humidity degradation.

G.R.

**A79-31408 Thermal performance evaluation of a flat-plate cylindrical parabolic concentrator and a flat-plate collector.** P. Singh and K. F. Schenk (Ottawa, University, Ottawa, Canada). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1.*

Winnipeg, Solar Energy Society of Canada, Inc., 1978. 13 p. 6 refs. Research supported by the National Research Council of Canada.

An investigation is conducted regarding the design, building, and testing of a flat-absorber cylindrical parabolic concentrator (CPC) and a conventional type of flat-plate collector. Experimental studies showed that the flat-absorber CPC is more cost-effective than the conventional flat-plate collector, if operated at solar noon under the specified conditions. Although the flat-absorber CPC utilizes much less absorber plate area, the total cost per unit area for both the collectors balances out because of the additional cost of the reflecting surface. However, it is expected that the cost of labor in building the parabolic surface would be reduced marginally by mass production. Another important consideration is that since the absorber width is large enough to receive even the off-axis incident rays, no tracking mechanism is needed. The collector can also be operated on cloudy or hazy days.

G.R.

**A79-31409 Studies on the effect of bed aspect ratios and pressure drop on flow distribution in rock bed storage systems for solar energy applications.** A. R. Balakrishnan, H. F. Sullivan, and K. G. T. Hollands (Waterloo, University, Waterloo, Ontario, Canada). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1.* Winnipeg, Solar Energy Society of Canada, Inc., 1978. 11 p. 5 refs. Department of Supply and Services Contract No. 12SQ-31155-7-4410.

A description is given of an experimental investigation of the flow distribution characteristics across any plane normal to the direction of flow and of the factors which affect these characteristics. The importance of ensuring even or uniform flow distribution to avoid any adverse effect on the thermal performance of the rock bed is pointed out. An indication of the flow distribution, i.e., the relative fluid velocity along a cross-section of the bed, was obtained using thermocouples measuring the air temperature. By monitoring the time taken for the temperature wave in the air stream to pass through a given depth of the bed at a given position in the bed cross-section and comparing this with a similar measurement at another location, a measure of the corresponding air velocities relative to one another is obtained.

G.R.

**A79-31410 Distributed energy storage for solar applications.** L. Holt and R. Scheithauer (U.S. Department of Energy, Div. of Energy Storage Systems, Washington, D.C.). In: *Renewable*

alternatives; *Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1.*

Winnipeg, Solar Energy Society of Canada, Inc., 1978. 9 p. 9 refs.

Energy storage systems have the potential to reduce electric utility peak load burdens and residential customer energy bills by storing electricity during off-peak periods, when generating costs are low, and making the electricity available during peak load periods. Two basic categories of storage systems are related to centralized energy storage at utility power stations and either customer or utility owned decentralized energy storage sited at the location of end use. The reported investigation focuses on distributed (i.e., decentralized) thermal storage for residential applications. Conventional hydro pumped storage is currently the only proven technology and is now in wide use. For the intermediate-term (1985-2000) advanced batteries appear to be attractive. Hydrogen storage system may also prove to be economic.

G.R.

**A79-31411 Measuring the quasi-Fermi level and flat band potential of an illuminated Au/n-GaAs<sub>6</sub>P<sub>4</sub>/4 anode.** W. E. Pinson (Infrared Photo, Ltd., Ottawa, Canada). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1.* Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 11 refs.

Winnipeg,

**A79-31412 Photovoltaic properties of metal-free phthalocyanines - A1/H2Pc Schottky barrier solar cells.** R. O. Loutfy and J. H. Sharp (Xerox Research Centre of Canada, Ltd., Mississauga, Ontario, Canada). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1.* Winnipeg, Solar Energy Society of Canada, Inc., 1978. 10 p. 10 refs.

At present the material and fabrication costs of inorganic solar cells are far above projected goals. On the other hand, organic photovoltaic devices potentially offer low material and device manufacturing costs. A new approach is presented to the fabrication of low cost organic solar cells, namely, the use of particulate semiconductors. The considered device consists of a solvent coated dispersion of photoactive particles in a polymer binder on a conductive substrate, and then a semitransparent barrier electrode evaporated on top of the organic film to form a Schottky barrier solar cell. To demonstrate the feasibility of the considered approach, polycrystalline x-metal-free phthalocyanine (x-H2Pc) was used for initial experiments. The reported work includes detailed photovoltaic studies on NESA/x-H2Pc cells.

G.R.

**A79-31413 A solar collector thermal performance test for developmental programs.** E. C. Shewen and K. G. T. Hollands (Waterloo, University, Waterloo, Ontario, Canada). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1.* Winnipeg, Solar Energy Society of Canada, Inc., 1978. 13 p. 8 refs. Department of Supply and Services Contract No. 12SQ-31155-7-4409.

An alternative thermal test procedure for solar collectors to that described in ASHRAE Standard 93-77 is described. Particularly suited to in-house developmental programs, the method permits a substantial reduction in the time required for test completion, while yielding an accuracy that should be comparable, for a given type of design. Considerable use is made of indoor heat loss testing and only one outdoor test is required. In this paper the method is outlined and a procedure for correcting the results to standard ambient conditions is described. A description of a test apparatus for air-heating collectors, built at the University of Waterloo is given and some experience in design of mixers and thermocouple collars is reported.

(Author)

**A79-31414 The role of applied meteorology in the Canadian energy programme.** D. C. McKay (Department of the Environment, Atmospheric Environment Service, Downsview,

## A79-31415

Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 13 p. 12 refs.

Conventional energy sources cannot withstand the present level of demand for long. Until improved sources are available in the desired quantities and locations, conservation of present energy stores is imperative. Conservation is an appealing alternative; from the viewpoint of return on investment, feasibility, and overall social benefits it vies favorably with other major energy development thrusts. To promote this energy alternative, applied meteorology can play a dominant role. To aid in the development of renewable resources and energy efficiency in residences and buildings in Canada, an Energy program has been initiated. The projects to be developed are initially in the realm of solar energy, wind energy, and energy efficiency. G.R.

**A79-31415** An ocean thermal difference power plant in the Canadian Arctic. R. K. Swartman (Western Ontario, University, London, Canada) and R. Green. In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 17 refs.

A variation on the scheme of using the temperature differences of the ocean waters is to use the Arctic atmosphere as the heat sink and ocean waters as the source. The proposed system uses a closed Rankine cycle operating between the temperatures of the Arctic Ocean and the colder Arctic atmosphere. The working fluid is evaporated in a vapor generator by the transfer of heat from seawater and is condensed after passing through a turbine, rejecting heat to the atmosphere. Two essential components of this proposal are a seawater-working fluid heat exchanger for the vapor generator and an air-working fluid heat exchanger for the condenser. G.R.

**A79-31416** Solar power plants. E. Bilgen and J. P. Bourquin (Lemieux, Monti, Nadon, Roy, Inc., Montreal, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 16 p. 9 refs.

It is estimated that Canadian oil and natural gas resources will be virtually exhausted before the year 2000. It is expected that the energy from nuclear fission will meet, in part, the additional demand during the next fifty years. On the other hand, the first commercial fusion reactors will probably not be available before the mid-21st century. Therefore, an alternative solution to meet short and long term energy needs is essential. The solution may be the better utilization of solar energy, an unlimited energy source. Attention is given to the prospects of solar energy in Canada, aspects of solar energy conversion, thermoelectric solar energy, the optical system, the central receiver power system, solar energy and utility companies, and existing and projected solar power plants. G.R.

**A79-31417** The Saskatchewan Conservation House - Some preliminary performance results. R. W. Besant, R. S. Dumont, and G. Schoenau (Saskatchewan, University, Saskatoon, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 17 p. 5 refs. Research supported by the Saskatchewan Housing Corp., Department of Mineral Resources, and Saskatchewan Research Council.

The performance of the Saskatchewan Conservation House for the spring of 1978 is reported. This house was designed primarily as a demonstration to the public of the energy savings possible in residential construction. The Saskatchewan Conservation House is one of a small number of residences constructed which are designed for 100% space heating using active solar collection systems. The provided report includes a listing of the theoretical and measured heat loss characteristics of the house, the passive solar gain behavior of the house, and efficiencies for the solar collector panels. Estimates

are made of the annual energy consumption of the house based on a normal occupancy pattern. G.R.

**A79-31418** Report on a survey of operational solar systems. D. Lorriman (Raymond Moriyama, Architects and Planners, Toronto, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 8 p.

During the winter and spring of 1978, a study was undertaken for the National Research Council to survey operational solar systems in North America - especially those operating in climates similar to Canada's. The purpose of the survey was to learn from the experiences gained from these systems and to report on any problems that may have developed in order to identify areas that require further research. Although the collector component of the systems received the most attention, other parts of the systems were also considered. The survey included a literature review, a mailed questionnaire programme and site visits to over 60 installations. This paper will summarize the findings of the survey. (Author)

**A79-31419** NRC solar monitoring program. S. A. Barakat, W. E. Carscallen, and B. E. Sibbitt (National Research Council, Div. of Building Research, Ottawa, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 14 p.

As part of the federal solar heating program, the Division of Building Research of the National Research Council is responsible for an on-going monitoring program of various solar installations. The aims of the program are to determine the solar contribution to the heating needs of buildings, to provide technical data for validating solar system simulation design methods and to permit analysis of subsystem performance. The paper describes the different levels of monitoring used by NRC and lists the buildings in which these monitoring systems are or will be installed. In particular, a description is given of the monitoring equipment installed in twelve federally-funded solar heated homes, as well as their installation and calibration. Some of the problems associated with the monitoring systems are also discussed. (Author)

**A79-31420** Performance of the Meadowvale solar home. B. E. Sibbitt, H. Jung, and D. Lorriman (National Research Council, Div. of Building Research, Ottawa, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 10 p. 6 refs.

Monitoring of the Meadowvale Solar Experiment in Mississauga, Ontario, began in October 1976 and has continued to date. The paper presents a performance summary of monitoring results of the first two complete heating seasons of solar system operation. Data for the period from October 1976 through April 1978 show that the solar system provided 51% of the space heating requirement, 14% of the service-water heating requirement and that 54% of collected energy was lost from storage. The paper also contains brief descriptions of the solar system, the house and the monitoring system. (Author)

**A79-31421** Off-peak electrical backup experience in the Meadowvale Solar Experiment. J. M. Bell (Ontario Hydro, Toronto, Canada) and D. Lorriman. In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 11 p.

When electricity is used for backup heating in solar heated houses, the maximum electric demand usually occurs when winter-peaking utilities are least capable of supplying it. An off-peak electric backup system was designed and incorporated into the existing storage system of the Meadowvale Solar Experiment to investigate the benefits and problems associated with this mode of operation. The paper describes the design and operation of the off-peak backup

system and contains suggestions for improvements. A comparison is made of the electrical demand and consumption for 1976-77 (on-demand electrical backup) to 1977-78 (off-peak electrical backup). The electrical load curve of the house is described and compared with the Ontario Hydro system load curve with a brief discussion of the potentials and the drawbacks of the use of off-peak power. Reference is made to other work programs in this area. (Author)

**A79-31422 Measured and predicted performance of solar domestic water heaters.** J. M. Bell and J. T. Strack (Ontario Hydro, Research Div., Toronto, Canada). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference*, London, Ontario, Canada, August 20-24, 1978. Volume 1.

Winnipeg, Solar Energy Society of Canada, Inc., 1978. 15 p. 7 refs.

Solar water heating offers good potential for the conservation of electricity in Ontario, since about half of existing water heaters in this province are electric. To examine the present state-of-the-art of commercially available solar water heater systems, Ontario Hydro has purchased and tested several systems. The paper describes the systems purchased, the test program and the results. The instrumentation package including special instrumentation developed for the tests is discussed. An outline is given of a simple analytical technique which was adapted to permit accurate prediction of the annual performance of any solar water heater system on a month by month basis. (Author)

**A79-31423 The performance of a site built, air heating, vertical collector with snow reflector in Quebec.** R. G. Kerr and M. M. Shapiro (Concordia University, Montreal, Canada.). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference*, London, Ontario, Canada, August 20-24, 1978. Volume 1.

Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 10 refs.

A screen-type vertical air heating collector with double glazing was installed in 1975 as the south wall of a house near La Macaza, Quebec, 170 km north of Montreal. The collector was built on site, using normal construction materials, for a gross cost of \$70/sq m, and a net cost of \$45/sq m, in 1975 dollars. The house and solar heater were monitored during the 1976-77 heating season. The noon efficiency curve of the collector compares favourably both with that of an experimental and with that of a factory-built collector. The monthly average efficiencies ranged from 32% in March to 42% in October. The ratio of solar heat to the sum of solar and baseboard heat supplied ranged from 0.29 in November to 0.76 in March, and was 0.5 over the entire heating season. Daily and monthly solar radiation and solar heat collected, plus monthly average efficiencies and solar fraction are presented. (Author)

**A79-31424 New approaches for the appropriate use of solar energy in northern climates.** T. A. Lawand, H. P. Budgen, C. Ives, J. LeNormand, A. Skelton, and L. Ghanime (McGill University, Sainte Anne de Bellevue, Quebec, Canada). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference*, London, Ontario, Canada, August 20-24, 1978. Volume 1:

Winnipeg, Solar Energy Society of Canada, Inc., 1978. 18 p. 6 refs.

A number of novel approaches in the field of solar heating are proposed for an investigation regarding a utilization in cold climate areas, taking into account attached solar rooms or greenhouses, modified Trombe walls, total roof canopies, solar heat pipes, and the long term potential of storing ambient heat and cold for the climatization of buildings. It is felt that these systems individually or in combination with standard passive heat gain techniques, will make significant contributions to the solar heating field in the future. G.R.

**A79-31425 Wind power from a vortex chamber.** P. N. Wang (Toronto, University, Toronto, Canada) and I. Huang (National Tsing Hua University, Hsinchu, Nationalist China). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference*, London, Ontario, Canada, August 20-24, 1978. Volume 1.

Winnipeg, Solar Energy Society of Canada, Inc., 1978. 9 p. 12 refs.

National Science Council of Nationalist China Contract No. 65E-0401-03(03).

In the utilization of wind energy, one of the major difficulties is the problem of low wind energy density. A new wind energy system employing the concept of confined vortex flow was proposed by Yen (1975, 1976, 1977) to overcome this difficulty. The new system, which is called tornado-type wind energy system, makes use of pressure energy. This energy is developed by utilizing the pressure difference between the ambient flow and the core of the confined vortex flow. The reported study has the objective to further investigate the feasibility of the considered approach. The pressure energy of the confined vortex flow is studied on the basis of a model test in the wind tunnel. G.R.

**A79-31426 NRC's wind energy program.** R. S. Rangi, P. South, and R. J. Templin (National Research Council, Ottawa, Canada). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference*, London, Ontario, Canada, August 20-24, 1978. Volume 1.

Winnipeg, Solar Energy Society of Canada, Inc., 1978. 15 p.

This paper describes current work on wind power assessment and on the Vertical Axis Wind Turbines at the National Research Council (NRC) Ottawa. A map showing the annual average wind power density is presented. The electrical wind power potential for all of Canada and individual provinces has been calculated from the wind power density. The wind power potential is also assessed for: (a) all land area, (b) existing electrical network +300 km, (c) existing electrical network +150 km. The theoretical and development work on the VAWT and also the demonstration projects that are sponsored by National Research Council are described. In particular, the preliminary performance data from the 200 kW Magdalen Island unit is included. (Author)

**A79-31427 The Prince Edward Island Wind Energy Program.** M. Lodge (Institute of Man and Resources, Charlottetown, Prince Edward Island, Canada). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference*, London, Ontario, Canada, August 20-24, 1978. Volume 1.

Winnipeg, Solar Energy Society of Canada, Inc., 1978. 13 p. 5 refs.

A description is presented of investigations related to the development of wind as a renewable and sustainable energy source in the Province of Prince Edward Island. The considered research and development program, which commenced in July 1977, is composed of four elements related to wind data, the integration of large Wind Energy Converter Systems (WECS), rural and farm applications of small WECS, and investigations conducted at an Atlantic wind test site. The analysis of the data obtained so far suggests that winds at exposed coastal locations in the Province of Prince Edward Island are sufficiently high to warrant the continued development and testing of a prediction model. G.R.

**A79-31428 Allowable costs for alternative domestic heating systems using utility supplied electricity for backup or charging energy.** A. G. Barnstable and P. L. Drewes (Ontario Hydro, Energy and Environmental Studies Dept., Toronto, Canada). In: *Renewable alternatives; Proceedings of the Fourth Annual Conference*, London, Ontario, Canada, August 20-24, 1978. Volume 1.

Winnipeg, Solar Energy Society of Canada, Inc., 1978. 15 p. 5 refs.

An outline is provided of the results of an Ontario Hydro Study which determines the economic potential for the development of various alternative heating systems from their projected electric demand characteristics. The economic potential for each system is derived through comparison of total utility plus homeowner costs with conventional electric heating. G.R.

**A79-31429 Component cost of solar energy systems.** J. F. Orgill and R. M. R. Higgins. In: *Renewable alternatives; Proceedings of the Fourth Annual Conference*, London, Ontario, Canada, August 20-24, 1978. Volume 1.

Winnipeg, Solar Energy Society of Canada, Inc., 1978. 17 p. 8 refs.

## A79-31430

The solar demonstration program of the Ontario Ministry of Energy is considered and the capital cost of demonstration projects is discussed, taking into account large solar energy systems, small solar energy systems, and a comparison with other demonstration programs. Future costs of solar energy systems are examined. It is pointed out that, as with the introduction of any new technology, the cost for the first systems is high. It has been found in the past, however, that a reduced cost per unit is achieved as the accumulated production volume increased. Attention is also given to the problems experienced in tendering solar collectors and solar systems in the demonstration program.

G.R.

**A79-31430 A cost effective vertical air/water solar heating collector.** T. H. Markowitz and R. L. Hummel (Toronto, University, Toronto, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 13 refs.

A description is presented of a vertical air/water collector which combines high efficiency with low cost. The low-cost characteristics of the total system are obtained by utilizing an air system for heat collection along with a water system for heat storage. The heat exchanger is in the top of the collector. It is protected from freezing, and is available to transfer heat from the collector to storage, or from storage to the building. The collector can be constructed from inexpensive materials. The incident direct solar radiation is almost doubled by employing a reflector, made of inexpensive aluminized Mylar plastic film.

G.R.

**A79-31431 Energy management through energy conservation in buildings.** R. W. Besant, G. J. Schoenau, and R. S. Dumont (Saskatchewan, University, Saskatoon, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 16 p. 31 refs.

It is pointed out that energy use in buildings is a major part of the total energy demand budget. Furthermore, buildings are a long term capital investment, much longer than the period for which energy supplies are assured at the low prices of today. Details regarding the energy dissipation in buildings operations at the present time are considered, taking into account the effects of a modification of present buildings related to a reduction in the consumption of energy. Questions regarding the reduction in energy consumption achievable in a new building designed to be energy conserving are also explored. It will be necessary to introduce a new energy code which will ensure that all future buildings will satisfy certain minimum long term energy conservation standards.

G.R.

**A79-31432 Collector and storage efficiencies in solar heating systems.** K. G. T. Hollands, J. W. Chinneck, and M. Chandrashekhar (Waterloo, University, Waterloo, Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 13 p. 10 refs. Department of Supply and Services Contract No. OSU77-00099.

A general definition of the efficiency of a solar collector operating in a solar energy system is presented which gives a fair method of comparison of different collectors operating in that particular application. Based on comparison between the areas required for the actual collector and that of a perfect collector - both giving the same fraction solar - the definition permits the definition of the average value of the collector input parameter. The concept of the perfect collector also leads to a fair definition for the efficiency of the storage component in a solar heating system. These parameters are evaluated for the special case of residential space heating and service hot water systems of the standardized t-chart type operating in a number of Canadian cities. Simple methods for collector comparisons result from the study and indications are that a simple solar system design method will follow.

(Author)

**A79-31433 Design study on solar energy systems for commercial buildings.** J. B. Bisset and P. F. Monaghan (Chorley and Bisset, Ltd., London, Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 13 refs. Research supported by Public Works Canada, National Research Council, and Department of Energy, Mines and Resources of Canada.

A description is presented of a preliminary study on design problems of applying solar energy to commercial buildings. The emphasis of the study is on practical aspects of design rather than on energy analysis. The problems of incorporating solar heating systems into the heating and cooling systems are considered along with the architectural and structural problems associated with mounting solar collectors on the building. The objectives of the study were to develop detailed conceptual designs for three solar system options and to estimate the relative costs of these systems, compared to two conventional heating and cooling systems.

G.R.

**A79-31434 Solar energy retrofit system for an older-type building - The Williamstown Museum project.** G. McKiel and E. Broomhall (John Abbott College, Sainte Anne de Bellevue, Quebec, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 13 p. 20 refs. National Research Council Contract No. 077-9.

The rationale for the retrofit of Williamstown Museum with a solar heating system was to provide the community with a high profile, easily accessible prototype which would engender interest and provide a design basis for solar systems in extant buildings. The space heat load base was designed on a 50 F indoor temperature and -20 F outdoor temperature to give a design temperature difference of 70 F. A flat plate, back pass modular solar collector was designed, measuring 3 x 16 ft. Though 16 collector modules were needed to provide 60% of the building's thermal demand another 5 modules were added to help offset losses in the long duct runs and the change from corrugated to flat absorber plate. The collectors were hoisted to the roof by a crane.

G.R.

**A79-31435 Solar heating and ventilation using the modified Trombe wall system (Chauffage et ventilation solaire par le système mur Trombe modifié).** E. Bilgen and M. Chaaban (Ecole Polytechnique, Montreal, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 7 p. In French.

A description is presented of the first stages of a theoretical and experimental investigation of the modified Trombe wall. The wall in its original form had first been considered by Trombe (1974). The Trombe wall as a solar energy collector has great thermal inertia. It performs a number of functions related to the collection of solar energy, the passing on of a part of the energy by means of a thermal circulation process, and the accumulation of the remainder of the energy in its own mass. A major problem of this system is the great loss of energy which takes place during the night. The investigation is concerned with the possibility to eliminate this drawback with the aid of an approach involving a separation of the energy collection and energy storage functions.

G.R.

**A79-31436 South wall solar collector with active collector system.** K. J. Linton. In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 8 p.

The south wall of the building is constructed to act as a Solar air collector. The collector system operates in conjunction with an air to water heat pump and water storage to collect the excess solar heat received. The heat pump extracts heat from the water storage to heat the house when this is required.

(Author)

**A79-31437 Domestic water preheating using solar energy.** V. M. Irerton (New Brunswick, University, Fredericton, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 11 p.

This paper reports upon the experience gained from the operation and monitoring of a closed loop solar energy collection system to preheat domestic water. The system has operated continuously and reliably since it was commissioned in late March 1977. Data collection began on April 1, 1977 and has continued to date. The contribution by solar energy to the preheating of the domestic water has been much less than that predicted by an f-chart analysis of the system as installed. The disagreement between experience and the f-chart model seems to be principally because of poor heat exchanger effectiveness and reverse thermal stratification in the preheat tank. It may be that drain-back or drain-down systems would be more effective than closed loop collection systems.

(Author)

**A79-31438 Economic design of a solar domestic water heating system.** G. K. Yuill (UNIES, Ltd., Winnipeg, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 9 p. Research supported by the National Research Council of Canada.

The described investigation had the objective to minimize the cost of a solar domestic water heating system designed to supply 50% of the energy required to heat the domestic hot water for a ten unit townhouse in Winnipeg. The townhouse will have a central mechanical equipment room where the solar energy equipment will be installed. The preheated water from the solar energy system will be fed into conventional gas fired domestic water heaters in the ten housing units. Aspects of computer program development for the optimization study are considered. The investigation showed that for a domestic water heating system, there is a physical optimum tank size. This is not true for space heating systems, for which system performance increases with tank size and the tank size is determined by an economic optimization. The cheapest of several single glazed collectors considered, was found to be the most cost effective. G.R.

**A79-31439 WATSUN - A simulation program for solar assisted heating systems.** M. Chandrashekhar, K. G. T. Hollands, N. T. Le (Waterloo, University, Waterloo, Ontario, Canada), and J. F. Orgill (Ministry of Energy, Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. Research supported by the National Research Council of Canada and Canadian Electrical Association.

WATSUN is a computer program, written in Fortran IV, designed to evaluate the economic and technical performance of different solar space heating designs. The original version of WATSUN is capable of simulating three types of solar heating systems, including a liquid base system with short term storage, an air base system with short term storage, and a liquid base system with long term seasonal storage. A revised version of WATSUN, called WATSUN-II, has also been developed for simulation of solar assisted heat pump systems. Models of six different solar assisted heat pump systems are added to the program. Details of the program organization, component models, system configurations, and performance indices are briefly discussed.

G.R.

**A79-31440 Validation of an electric circuit model of a solar house.** R. D. McConnell (IREQ, Varennes, Quebec, Canada), R. G. Kerr, and M. M. Shapiro (Concordia University, Montreal, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 12 refs.

Meteorological, electrical and temperature measurements were recorded at fifteen minute intervals during the 1976-77 heating season in a solar house located near the village of La Macaza, Québec. A computer model was developed which simulates the house and its solar heating system. Thermal resistances are modelled by electric resistors, solar radiation by a current source, temperatures by electric voltages and thermal storage units by electric capacitors. A validation of the electric circuit model is described in which the responses of the model, to incident solar radiation, ambient temperature, and internal heat generation data, are compared with the recorded temperatures in the collector, in the solar storage unit and in the house, during four-day periods in February, 1977. Reasonable agreement is found.

(Author)

**A79-31441 Mathematical modelling of passive solar systems.** C. Carter (Trent University, Peterborough, Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 6 refs.

Calculations of heat gains and losses in buildings invariably use a linear approximation, usually without explicit mention of the fact. Actually, of course, both convection and radiation are nonlinear effects. The standard method of calculating heat losses for active solar collectors due to Duffie and Beckman (1974) treats the convective and radiative losses as nonlinear effects, and uses an iterative approach to obtain the temperatures and heat flows in various parts of the collector. In practice, the second iteration usually produces only a small correction to the first values calculated, thus indicating that a quasi-linear approximation might be adequate in most cases. For passive solar systems, the smaller temperatures would make a linear approximation even more reliable. Attention is given to the development of various other simplifications which follow once a linear approximation is adopted. G.R.

**A79-31442 Control system for solar hot water system.** M. J. Lesperance, R. M. Tomita, and S. Cadieux (Atelier Solaire Enrg., Pointe Claire, Quebec, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 7 p.

Although the solar energy industry is relatively young, it has a certain maturity through the industries which service it. One of these industries is the process control industry. In order that the solar industry benefits from the experience acquired by the process control industry, it is essential to apply the accepted standard practices. The processes found in a solar energy heliothermal system are comparable in their simplest form to a heat exchange loop where the sun is the heat source. The variables to control include temperatures, flows, and pressures. The common practices in the process control industry are examined, taking into account the application of these practices to the solar energy industry and, particularly, to hot water heating systems using fixed flat plate collectors.

G.R.

**A79-31443 Solutions to energy conservation in northern climates.** E. J. Tymura (Tymura Solardesigns, Thunder Bay, Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 14 p. 14 refs.

In connection with the limitation of fossil fuels, it is imperative that architectural designs evolve to conserve energy through the development of energy efficient buildings. Principles and advantages of terraculture, passive solar heating, active solar water heating, and regional climatic considerations have been coordinated to govern the design of a working solution to these present and future architectural concerns. Attention is given to design in response to the environment, various approaches for energy conservation, and the implementation of these approaches in a solar heated residence. G.R.

**A79-31444** Passive solar heating - Results from two Saskatchewan residences. R. S. Dumont, R. W. Besant (Saskatchewan, University, Saskatoon, Canada), G. Jones (Botting and Associates, Ltd., Saskatoon, Canada), and R. Kyle (Aquitaine of Canada, Ltd., Rainbow Lake, Alberta, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 17 p. 13 refs.

A description is presented of two houses incorporating design principles of passive solar heating. The dwellings were completed in the winter of 1977-78, one located in Saskatoon and the second in Regina. Performance tests on the houses were conducted in the spring of 1978. Both of the dwellings were of a direct gain type, with southerly oriented windows and no vertical thermal mass such as a concrete wall behind the windows. The performance tests show that passive solar heating can contribute a large fraction of the heating requirements. For the Regina residence, the contribution of passive gains should amount to 44% of the heating requirement during the heating months. Thermal shutters can be of significant value in reducing both the heat loss from dwellings and in moderating the temperature falls at night in well insulated dwellings. G.R.

**A79-31445** Measured and modeled passive performance in Montana. L. Palmeter, W. Caswell, and R. J. Corbett (National Center for Appropriate Technology, Butte, Mont.). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 9 p.

Several passive solar test units have been constructed at The National Center for Appropriate Technology. The design, instrumentation and performance of the direct gain and Trombe wall cells are discussed. Preliminary results of a simple computer model for simulating air and storage wall temperatures are presented. (Author) G.R.

**A79-31446** Integration of a passive and active solar heated low density, multiple dwelling with atrium. T. G. Lee (Calgary, University, Calgary, Alberta, Canada) and D. H. Jenkins (Bill Bouchard Partnership, Calgary, Alberta, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 14 p.

The considered passive heating principle involves the capture of solar energy in a glazed atrium court utilizing the 'greenhouse' principle. The heat generated by the atrium in excess of its own requirements is used to provide direct heat to the units, provide partial heat, supplemented by a conventional gas fired forced air system, and provide short term heat storage by drawing the excessive heat into a rock storage, to be later reused. Solar radiation passes through the glazing of the atrium to heat the space within. An insulating shutter will cover the atrium during the evenings or periods of prolonged cloudiness to prevent heat loss. G.R.

**A79-31447** The honeycomb heat trap - Its application in flat plate solar collectors. D. Hart (Watershed Energy Systems, Ltd., Toronto, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 10 p.

It is pointed out that a collector operating under Canadian midwinter conditions loses the major portion of its energy back through the covers and sides to the outside air. The primary mechanisms for this heat loss are examined along with the approaches used to reduce the effectiveness of these mechanisms. It is found that very few collector designs incorporate any means for suppressing free convection, which is the major source of heat loss. One such collector is the evacuated-type collector. A description is presented of another approach involving the use of honeycomb cells to suppress convection. It was found that by partitioning the air layer between the hot and cold surfaces, convective motion could be virtually eliminated. In a comparison of the performance of various solar collectors it was found that honeycomb panels provided 61.7%

of the annual heating load for a house, while air collectors of the same area supplied only 44.2% of the load. G.R.

**A79-31448** Cylindrical parabolic collector optimization for interfacing with steam turbine generators. M. G. Psوفogiannakis and E. G. Plett (Carleton University, Ottawa, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 6 p.

An investigation is conducted regarding the feasibility to generate electricity using a steam cycle with the steam generated in a solar collector. Steam generation in a flat plate collector is possible, but its collecting efficiency becomes unattractively low at the high fluid temperature range required to generate steam. For this reason, a focussing collector shows promise of being a more viable means of generating steam. A hypothetical plant to use solar-thermally generated steam to generate electricity takes in water in the 90 to 100 °C range, it is pressurized to 20 to 30 bars and then passed through the solar collector in which it is converted to steam at about 400 °C. The steam is expanded in a conventional turbine which drives an electrical generator. The feasibility of such a system depends on the design, operation, and economics of the solar collector. The technical aspects of collector optimization are examined, taking into account the use of a cylindrical parabolic reflector. G.R.

**A79-31449** Sensible heat storage for solar energy applications. R. K. Romak and P. P. Von Hatten (Western Ontario, University, London, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 8 p.

In the field of solar energy, rocks are the most commonly used media for sensible heat storage. The use of other solid materials has not been adequately considered. This paper studies a group of eight selected materials. These include three sizes of rocks, clay balls, broken drainage tile, brick rubble, iron oxide pellets and blast furnace slag. Initially the materials' properties were analyzed. This was based on size, shape, density and thermal characteristics of the materials. Each material was then tested. A model heat storage unit was constructed to perform heating, cooling and pressure drop tests. These results combined with costs produced the material most suitable. It was found that the ideal material consists of small particles, has high density and heat capacity and packs with a small void ratio. The 3/4 in. stone was selected as most suitable. (Author)

**A79-31450** The first year of solar collector testing at Ontario Research. R. W. Bertram and G. Norgate (Ontario Research Foundation, Mississauga, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 16 p. 8 refs.

**A79-31451** Studies on solar collector performance at NRC. S. J. Harrison and J. R. Sasaki (National Research Council, Div. of Building Research, Ottawa, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 8 refs.

As part of NRC's responsibility for the development of solar heating standards and test methods, a facility has been established at the Division of Building Research (DBR) to obtain data on the thermal performance and durability of solar collectors. A variety of solar collectors are being tested to determine the factors that affect their performance and life. A review of testing procedures is underway to assess their suitability for use in Canada. This paper describes the solar calorimeter apparatus and the in-house activities currently being pursued at DBR. (Author)

**A79-31452** Statistical analysis of solar radiation data in Montreal for solar energy utilization. C. Guaymard, D. Labelle, E.

Bilgen, and F. Laframboise (Ecole Polytechnique, Montreal, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 13 p. 7 refs.

A79-31453 First year performance data and lessons learned in the NRC 14 house solar demonstration program. W. E. Carscadden and B. E. Sibbitt (National Research Council, Div. of Building Research, Ottawa, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 14 p.

A79-31454 Alternate energy installations on the Jordan College Campus. L. K. Coxon (Jordan College, Cedar Springs, Mich.). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 8 p.

The considered energy installations include a flat plate air system that stores its solar heat in rocks, a flat plate drain down solar system for space heating and domestic hot water that stores its heated liquid in tanks, and a drain down do-it-yourself domestic water system using flat plate collectors. Attention is also given to a do-it-yourself air system that stores its heat in rocks and a concentrating high temperature liquid solar system for space heating, domestic hot water, and cooling. A solar greenhouse is also considered along with photovoltaic collectors for electricity generation. G.R.

A79-31455 A hybrid wind turbine suitable for developing regions. E. Bilgen, I. Paraschivoiu, and M. Kaine (Ecole Polytechnique, Montreal, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 6 p. 5 refs.

In this article, a study is presented on a hybrid wind turbine which consists of two vertical axis coaxial turbines, one of Savonius type and the other a screw type. The Savonius type turbine rotates in a uniform velocity field while the second, the screw type converts the kinetic energy of the vortex flow generated in the center of the first turbine. Theoretically, it is shown earlier that the total efficiency of such a hybrid wind turbine can have a higher efficiency compared to that obtained from a simple system and the simplicity of the Savonius for manufacturing and maintenance of the system is retained. A model has been built to study the overall performance of this system, the results of which will serve to design and build a prototype hybrid turbine for the Northern regions of Quebec.

(Author)

A79-31456 Determination of the potential for solar retrofitting in Edmonton. J. F. McLaughlin (Solar Energy Society of Canada, Inc.; Alberta, University, Edmonton, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2.

Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p.

The paper focuses on the methodology adopted for a pilot study which is currently being undertaken in Edmonton to determine the potential for adding active solar energy systems onto existing single family dwellings. Of particular importance is the sampling procedure, and the field methods utilized. Preliminary results and analysis are presented for one of the four neighborhoods selected for surveying. This neighborhood, Garneau, was constructed during the period 1946 to 1959. While over one half of the homes in the Garneau sample have south-facing roofs, many of these have limited or poor retrofit potential for roof collectors due to construction and shading problems. Alternative collector locations on the properties are also briefly discussed. The technical problems of mounting solar panels onto existing structures and integrating the 'solar assist system' into

conventional hot water and space heating systems are presented in chart form. (Author)

A79-31457 Solar heating of domestic hot water at the Confederation Heights Cafeteria. D. H. Hampton and T. Lefevre (Public Works Canada, Ottawa, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 9 p.

A79-31458 P.E.I. solar assisted domestic water heat project. C. K. Brown (Institute of Man and Resources, Charlottetown, Prince Edward Island, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 10 p.

A79-31510 The influence of fuel composition on smoke emission from gas-turbine-type combustors - Effect of combustor design and operating conditions. N. J. Friswell (Shell Research, Ltd., Thornton Research Centre, Chester, England). *Combustion Science and Technology*, vol. 19, no. 3-4, 1979, p. 119-127. 9 refs.

The influence of fuel composition on smoke emission/combustor wall temperatures has been studied in a laboratory-scale gas-turbine-type combustor over the range of operating conditions of modern turbine combustors and as a function of combustor design. Fuel hydrogen content is shown to give the best prediction of smoke emission and of variations in flame tube wall temperature caused by changes in flame radiation. The major finding is that the influence of fuel composition on smoke emission/flame radiation falls virtually to zero at combustor pressure above about 10 bar. Significant reduction in sensitivity to fuel composition can also be obtained by varying combustor design and are tentatively correlated with increasing combustion intensity. The implication of these effects for aircraft operation is discussed and an explanation for the results is put forward based on changes in the chemical mechanisms leading to soot formation. (Author)

A79-31554 A numerical model investigation of tidal phenomena in the Bay of Fundy and Gulf of Maine. D. A. Greenberg (Environment Canada, Marine Environmental Data Services Branch, Ottawa, Canada). *Marine Geodesy*, vol. 2, no. 2, 1979, p. 161-187. 21 refs.

A numerical model is developed to examine tidal properties of the Bay of Fundy and Gulf of Maine. The model is run with a pure M2 tidal input on the open boundary, and calibrated by adjusting the friction coefficient to achieve good agreement with inshore observations. An examination of aspects of the tidal regime is made, with particular attention paid to the upper reaches of the bay. Mean energy and work values are computed. The fundamental period of the system is estimated. The effects of tidal power plants on the tidal regime are examined. (Author)

A79-31615 # Dynamics of stepping of the Hermes flexible solar array. D. M. Gossain (Spar Aerospace, Ltd., Toronto, Canada). *Canadian Ronautics and Space Journal*, vol. 25, 1st Quarter, 1979, p. 50-60.

The Communications Technology Satellite 'Hermes', in synchronous orbit since February 1976, is a 3-axis stabilized spacecraft, with the drive and track mechanisms rotating the base of the solar array at 0.25 deg every minute, in two 'steps' of 0.125 deg each. Dynamics anomalies encountered in array-stepping during the design of the system are described, together with a presentation of the analysis involving modelling the dynamic characteristics of the system using inertia, spring and dash-pot elements and simulation on a digital computer. Results of the analysis are discussed, with attention given to nominal stepping, fast-slew, and final design. It is indicated that the fast-slew mode can become unstable for some pulse-widths, with the width of the unstable zones depending on the energy dissipation characteristics. Increasing damping is shown to reduce the width of the unstable zones. A.A.

**A79-31754** Plasma behavior near the neutral line between parallel currents. G. G. Zukakishvili, I. F. Kvartskhava, and L. M. Zukakishvili (Akademii Nauk Gruzinskoi SSR, Fiziko-Tekhnicheskii Institut, Sukhumi, Georgian SSR). (*Fizika Plazmy*, vol. 4, July-Aug. 1978, p. 725-734.) *Soviet Journal of Plasma Physics*, vol. 4, July-Aug. 1978, p. 405-410. 19 refs. Translation.

Experiments on the plasma behavior in planar Z pinches are described. The initial stage of the discharge leads to the formation of two current filaments that are separated by a magnetic-field neutral line. The filaments move toward each other. As a result of the motion of the original filaments, new regions of enhanced particle density (secondary filaments) appear in the intermediate plasma, and the return current flows through them. The electric field is calculated near two parallel moving currents. When the conductors are moving in opposite directions, an induced electric field appears between them; this electric field is antiparallel to the currents in the conductors. The total electric field in the neutral region of a system of linear parallel currents can be higher than the applied electric field in the moving conductors, and if the particle density is low, a stream of fast accelerated charged particles can appear in this region.

(Author)

**A79-31760** Relaxation of a fast ion beam in a tokamak plasma. V. M. Bardakov (Akademii Nauk SSSR, Institut Zemnogo Magnetizma, Ionosfery i Raspredeleniya Radiovoln, Irkutsk, USSR). (*Fizika Plazmy*, vol. 4, July-Aug. 1978, p. 789-798.) *Soviet Journal of Plasma Physics*, vol. 4, July-Aug. 1978, p. 443-448. 16 refs. Translation.

The quasi-linear relaxation of a fast ion beam due to unstable Alfvén waves is analyzed in connection with the problem of a two-component tokamak. Quasi-linear relaxation is incorporated in a calculation of the thermonuclear efficiency (Q) of a two-component tokamak fusion reactor. If the quasi-linear relaxation is assumed to occur instantaneously, the thermonuclear Q is lower than the classical value, calculated for purely Coulomb relaxation of the beam, by an average of a factor of five. Magnetic shear causes a nearly instantaneous quasi-linear relaxation by stable Alfvén noise in the absence of shear to convert into a slow diffusive spreading of the beam distribution function. This spreading comes to a halt in a time comparable to the characteristic Coulomb time. The local value of Q falls off significantly in this case only near the center of the plasma column, where the shear is small. Q averaged over the column, on the other hand, decreases by only a few percent from the classical value if the beam density does not have a maximum at the center of the plasma column.

(Author)

**A79-31762** Experiments on controlling the plasma density in the TO-1 tokamak. L. I. Artemenkov, E. V. Grodzinskii, N. V. Ivanov, A. M. Kakurin, and V. S. Svirshchev (Akademii Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). (*Fizika Plazmy*, vol. 4, July-Aug. 1978, p. 812-817.) *Soviet Journal of Plasma Physics*, vol. 4, July-Aug. 1978, p. 457-460. 8 refs. Translation.

Experiments on neutral-gas injection into the chamber of the TO-1 tokamak are described. The gas inlet valve is controlled by a predetermined program or automatically as a function of the time evolution of the MHD activity of the discharge. The density can be adjusted over a broad range by adjusting the gas injection. The rate of increase of the relative MHD activity is studied as a function of the discharge characteristics. Certain plasma properties are measured during the injection. With automatic control of the inlet valve the plasma density can be increased substantially and held at the new level throughout most of the discharge pulse in the tokamak.

(Author)

**A79-31763** Calculation of the Q factor for a two-component tokamak. V. M. Bardakov and V. I. Pustunovich (Akademii Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). (*Fizika Plazmy*, vol. 4, July-Aug. 1978, p. 818-821.) *Soviet Journal of Plasma Physics*, vol. 4, July-Aug. 1978, p. 460-462. 9 refs. Translation.

The extent to which mutual collisions of deuteron-beam particles affect the ion distribution and Q factor of a two-component tokamak is considered, along with the sufficiency of a quasi-linear approximation in which mutual collisions of beam particles are ignored but the effect of the beam on the background plasma is taken into account. The evolution of a two-component tokamak system is examined on the assumption that the plasma energy lifetime is long. The results indicate that the Q factor for models more complicated than the two-component tokamak can be calculated by solving the cited quasi-linear problem. The error in determining the Q factor is shown to be no more than 5% in comparison with the exact nonlinear problem.

F.G.M.

**A79-31764** Heat transport near the wall of a tokamak reactor. V. G. Petrov and M. Z. Tokar (Akademii Nauk SSSR, Institut Vysokikh Temperatur, Moscow, USSR). (*Fizika Plazmy*, vol. 4, July-Aug. 1978, p. 822-825.) *Soviet Journal of Plasma Physics*, vol. 4, July-Aug. 1978, p. 462, 463. 9 refs. Translation.

The region near the wall in which the plasma interacts with neutral atoms is studied. The kinetic equation with charge exchange and ionization is solved for the neutrals. The plasma is described hydrodynamically because the gyroradii are small. The calculated results are the distributions of the plasma and neutral gas properties near the wall.

(Author)

**A79-31765** A scheme for direct conversion of plasma thermal energy into electrical energy. A. V. Timofeev (Akademii Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). (*Fizika Plazmy*, vol. 4, July-Aug. 1978, p. 826-834.) *Soviet Journal of Plasma Physics*, vol. 4, July-Aug. 1978, p. 464-468. 9 refs. Translation.

A recovery device is described for implementing a scheme whereby the thermal energy of a plasma is directly converted into electrical energy as the charged plasma particles drift in a region of crossed electric and inhomogeneous magnetic fields. An energy-recovery principle is outlined which involves the use of magnetic mirrors and the electrical contact between the plasma confined in the recovery device and electrodes located beyond the mirrors. Problems associated with plasma stability, plasma contact with the end electrodes, and plasma injection into the recovery device are considered. Properties of the proposed recovery device are compared with those of the Post device, which consists of an expander and a collector.

F.G.M.

**A79-31766** Dynamic stabilization of toroidal discharges in weak longitudinal magnetic fields. I. M. Roife, M. A. Vasilevskii, and E. V. Seredenko (Nauchno-Issledovatel'skii Institut Elektrofizicheskoi Apparatury, Leningrad, USSR). (*Fizika Plazmy*, vol. 4, July-Aug. 1978, p. 835-841.) *Soviet Journal of Plasma Physics*, vol. 4, July-Aug. 1978, p. 469-472. 19 refs. Translation.

Experiments on the production of a stable plasma column with  $q$  less than unity in the TT-3 and Toloskop devices are reported. The experiments were carried out to create a stable hot (highly conducting) plasma capable of producing stable magnetic-column conditions in fusion devices of the Zeta and Alpha types. The stability was studied by a dynamic-stabilization method with high-frequency modulation of the approximately steady discharge current. It is concluded that the observed suppression of the MHD instability with  $m = 1$  is due to the combined effects of the induced currents in the conducting wall and the radial magnetosonic plasma waves that are excited. With a 'clean' vacuum chamber, it is possible in this case to achieve stable operation for discharges in fusion devices like Zeta and Alpha.

(Author)

**A79-31845** Combustion of hydrogen in a supersonic flow in a channel in the presence of a pseudodiscontinuity. V. L. Zimont, V. M. Levin, and E. A. Meshcheriakov. (*Fizika Goreniia i Vzryva*, vol. 14, July-Aug. 1978, p. 23-36.) *Combustion, Explosion, and Shock Waves*, vol. 14, no. 4, Jan. 1979, p. 424-435. 17 refs. Translation.

Hydrogen combustion in a supersonic channel flow in the presence of an extended region of transition from supersonic to subsonic flow (a pseudodiscontinuity) is investigated experimentally and numerically. Experimentally determined pressure distributions show the presence of combustion to lessen the increase of pressure associated with a pseudodiscontinuity formed by flow throttling in a channel of variable cross section. In a cylindrical channel, a reduction of the excess oxidant factor or the stagnation temperature of the oxidant leads to an upstream displacement of the zone of pressure increase, indicating more complete combustion. A flow model based on the integral method of calculating the pseudodiscontinuity in the channel is derived with the addition of jet and wake mixing factors, to account for combustion heat release. Results of model calculations of pressure and Mach number distributions are shown to agree well with experimental values.

A.L.W.

**A79-31908** Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. Conference sponsored by the Royal Aeronautical Society and American Institute of Aeronautics and Astronautics. London, Royal Aeronautical Society, 1979. 336 p. \$35.

The energy research and development program of the U.S. is considered along with aspects of energy research and development on the basis of a UK view, prospects for reducing the fuel consumption of civil aircraft, the NASA aircraft energy efficiency program, aviation fuel from coal, commercial transports in the 1980s, the impact of aeronautical sciences on other modes of transport, and oil exploration from space. Attention is also given to the design and application of large wind turbine generators, off-shore multi-MW wind turbine system development as key to cost-effective wind energy for Sweden, a review of some critical aspects of satellite power systems, a preliminary assessment of the environmental impact of satellite power systems, European aspects of solar satellite power systems, and photovoltaics and solar thermal power systems.

G.R.

**A79-31909** # The Energy Research and Development Program of the United States. D. D. Myers (U.S. Department of Energy, Washington, D.C.). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 11 p.

The world energy system is considered along with the situation in the U.S., the national energy act, the progress achieved in the U.S. with respect to the conservation of energy, aerospace experience which is applicable to the solution of energy problems, and aspects of organization for research and development. Attention is given to work conducted in the area of central solar technology, photovoltaics, wind turbines, fuel cells, the breeder reactor, fusion, and the solar power satellite.

G.R.

**A79-31910** # Energy research and development - A U.K. view. H. Bondi (Department of Energy, London, England). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 8 p.

Developments in the UK related to energy conservation are examined, taking into account the approaches for an economic use of energy which can be provided by aerospace technology and, in particular, solid state electronics. Attention is also given to the employment of offshore technology to gain hydrocarbon resources from below the sea, research and development which is being carried out by the energy supply industries, developments in the nuclear field, the utilization of wave energy, the solar energy program, a use of geothermal energy, the significance of tidal energy, and aspects of cogeneration.

G.R.

**A79-31911** Prospects for reducing the fuel consumption of civil aircraft. G. G. Pope (Royal Aircraft Establishment, Farn-

borough, Hants., England). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 21 p. 10 refs.

An outline is provided of technological advances that will contribute to the reduction of fuel consumption. Attention is concentrated mainly on advances being made in the UK. The emphasis is on developments that can be exploited in the generation of aircraft which will succeed the more recent of the transport aircraft types now in service and those which will reach the airlines in the early 1980s. Advances in powerplants are examined along with developments in aerodynamics, taking into account advances in design techniques, experimental facilities, wing tip design, drag reduction, and laminar flow control. Attention is also given to materials and structures, active control technology, and operational considerations.

G.R.

**A79-31912** # The NASA Aircraft Energy Efficiency program. J. M. Klineberg (NASA, Washington, D.C.). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 19 p.

A review is provided of the goals, objectives, and recent progress in each of six aircraft energy efficiency programs aimed at improved propulsive, aerodynamic and structural efficiency for future transport aircraft. Attention is given to engine component improvement, an energy efficient turbofan engine, advanced turboprops, revolutionary gains in aerodynamic efficiency for aircraft of the late 1990s, laminar flow control, and composite primary aircraft structures. G.R.

**A79-31913** # Aviation fuels from coal. J. Gibson (National Coal Board, London, England). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 16 p.

Although the ultimate aviation fuel may prove to be liquid hydrogen produced from water by electrolysis using nuclear power, there are powerful arguments to continue to use hydrocarbon fuels and as much as possible of the infrastructure associated with them. In effect, the objective must be to bridge the gap until reliance can shift to nuclear-based fuel and that is still far off. Attention is given to the world fuel reserves, the demand for aviation fuel, the principles of coal liquefaction, conventional and unconventional aviation fuels from coal, coal liquefaction processes, and possible alternative strategies. The current status and potential for aviation fuels from coal are considered and the UK program on coal liquefaction is discussed.

G.R.

**A79-31915** # The impact of aeronautical sciences on other modes of transport. I. C. Cheeseman (Southampton University, Southampton, England) and A. H. Wickens (British Railways Research and Development Div., London, England). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 22 p.

The development of theories and numerical methods appears to represent the greatest impact of aeronautical science on the other modes of transport. The energy characteristics of air, rail, and road transport are examined. The effect of fuel costs on the overall operating costs are greatest in the case of aircraft. This means that the operating price increase which can be accepted in order to improve fuel economy is lower for road and rail than for air. Although the problems which have to be solved in the three modes are similar, for example, reduced weight, lower aerodynamic drag, and improved prime mover efficiency, solutions which are acceptable for aircraft do not generally apply to the other modes. The gas turbine which predominates in industry has attractions for the other modes. However, rail electrification offers much greater gains and at the same time makes that form of transport less dependent on oil-based fuels.

G.R.

**A79-31916 # Design and application of large wind turbine generators.** D. F. Warne (Electrical Research Association, Ltd., Leatherhead, Surrey, England). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 15 p. 12 refs.

An outline is provided of several national programs which are concerned with the construction of new machines for the utilization of wind energy. General factors governing economics are examined, taking into account the importance of wind speed, the importance of scale, and the rate of machine output. Design choices in large wind turbine generators are also discussed, giving attention to design decisions related to turbine type, the turbine diameter, aspects of pitch control, the number of blades, the choice of fixed or variable turbine speed, the significance of upwind or downwind location as a design option, and the general question of system stiffness. G.R.

**A79-31917 # Off-shore multi-MW size wind turbine system development is the key to cost-effective wind energy for Sweden.** O. Ljungstrom (Forsvardsdepartementet, Flygtekniska Forsoksanstalten, Bromma, Sweden). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 13 p. 6 refs.

**A79-31918 # The JET project - A step towards the production of power by nuclear fusion.** A. Gibson. In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 15 p.

JET is to be a large tokamak experiment designed to take advantage of some recent advances and to set the stage for the construction of a future fusion reactor experiment. The objective of the JET experiment is to obtain and study a plasma in conditions and dimensions which approach those needed in a fusion reactor. The realization of this objective involves four main areas of work which are related to the study of the scale-up of the confinement properties, the study and control of plasma-wall interaction and impurity influx, the demonstration of effective heating techniques, and an operation in conditions where alpha-particles from deuterium-tritium reactions are produced and confined. G.R.

**A79-31919 # Status of the SPS concept development and evaluation program.** F. A. Koomanoff (U.S. Department of Energy, Satellite Power Systems Projects Office, Washington, D.C.). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 17 p.

The Satellite Power System (SPS) is designed to capture solar radiation in geosynchronous orbit and, by means of photovoltaics, convert the solar energy to electrical energy. The current status of the SPS program is discussed by describing the systems definition activities, environmental and societal assessment activities, and the comparative assessment directions. The organization and funding for these activities are also presented. It is concluded that to date no program stoppers have been found, however, many significant questions remain unanswered; questions which must be answered before the next steps may be reached in determining if SPS is indeed an energy option for mankind. G.R.

**A79-31920 # Solar Power Satellite systems definition.** G. R. Woodcock (Boeing Aerospace Co., Seattle, Wash.). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 47 p.

A summary is provided of the results obtained in a detailed investigation of the technical and cost feasibility of Solar Power Satellites (SPS). Attention is given to SPS configuration options, the

photovoltaic energy conversion, a recommended gallium arsenide satellite concept, the radiation degradation of solar cells, questions of power distribution, microwave power transmission, microwave generation technology, phase control, the power receiver system, ground-based power processing technology, laser power transmission, space transportation to low earth orbit, space-based construction and transportation operations, costing methods, cost analysis methodology, SPS cost ranges, economic analyses, resources requirements, and aspects of development and implementation. G.R.

**A79-31921 # A review of some critical aspects of satellite power systems.** I. V. Franklin (British Aerospace, Dynamics Group, Weybridge, Surrey, England) and A. W. Rudge (Electrical Research Association, Ltd., RF Technology Centre, Leatherhead, Surrey, England). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 18 p. 13 refs.

Some critical aspects of the Solar Power Satellite (SPS) are considered. The basic concepts of the SPS are considered along with aspects of SPS delivery and construction systems, solar arrays, on board electrical power collection, costs, European activities, and questions of development strategy. The SPS microwave system is examined, taking into account basic operations and constraints, the baseline microwave system, major areas of uncertainty, and the space antenna. G.R.

**A79-31922 # Preliminary assessment of the environmental impacts of the Satellite Power System /SPS/.** S. L. Halverson, D. M. Rote (Argonne National Laboratory, Argonne, Ill.), C. M. Rush (National Telecommunications and Information Administration, Institute for Telecommunication Sciences, Boulder, Colo.), K. Davis (Battelle Pacific Northwest Laboratories, Richland, Wash.), M. White (California University, Berkeley, Calif.), and D. F. Cahill (U.S. Environmental Protection Agency, Research Triangle Park, N.C.). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 17 p.

Investigations required to assess the health and ecological effects of microwaves are considered. In addition to the impacts of microwaves, a number of other health and safety effects can be anticipated from the deployment of a Solar Power Satellite (SPS). Factors that are unique to the SPS deployment are related to the handling of large quantities of gallium arsenide for solar cells and the exposure of construction workers to extended periods of space radiation. Attention is also given to the effects on the atmosphere, aspects of electromagnetic compatibility, and ionospheric heating and vehicle effluent effects. G.R.

**A79-31923 # European aspects of Solar Satellite Power systems.** M. Trella and K. K. Reinhartz (ESA, Noordwijk, Netherlands). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 17 p. 18 refs.

It is pointed out that energy-related problems are potentially much more serious in Europe than in the U.S. The proposal is, therefore, made that European countries should investigate the prospects offered by the SPS as a future source of a part of the energy needed by them. An outline is presented of the specifically European problems which have to be investigated to evaluate the SPS concept. Possible European activities are examined, taking into account a concept evaluation, studies related to energy conversion, space construction and operation, power transmission and distribution, transportation, and the selection criteria for technological research. Program considerations and financial aspects are also explored. G.R.

**A79-31924 \* # Photovoltaics and solar thermal conversion to electricity - Status and prospects.** M. E. Alper (California Institute of

Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 16 p. 16 refs.

Photovoltaic power system technology development includes flat-plate silicon solar arrays and concentrating solar cell systems, which use silicon and other cell materials such as gallium arsenide. System designs and applications include small remote power systems ranging in size from tens of watts to tens of kilowatts, intermediate load-center applications ranging in size from tens to hundreds of kilowatts, and large central plant installations, as well as grid-connected rooftop applications. The thermal conversion program is concerned with large central power systems and small power applications.

G.R.

A79-31925 \* # The Solar Power Satellite concept - Towards the future. C. C. Kraft, Jr. (NASA, Johnson Space Center, Houston, Tex.). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978.

London, Royal Aeronautical Society, 1979. 12 p.

An evolutionary program phasing with respect to the development of a Solar Power Satellite (SPS) is considered, taking into account concept identification, concept evaluation, exploratory research, space technology projects, system development, and commercial operations. At the present time the concept evaluation phase of the program is underway. This phase is scheduled for completion in 1980. It will result in a recommendation as to whether the concept should be explored further and if so, in what manner. The recommendation will be based on technical feasibility, economic and environmental considerations, and comparisons with other potential systems of the future. It is premature to speculate on the conclusions and recommendations from the evaluation program as to whether the program should proceed to the next phase.

G.R.

A79-31951 Metallurgical coatings 1978; Proceedings of the Fifth International Conference, San Francisco, Calif., April 3-7, 1978. Volumes 1 & 2. Edited by R. F. Bunshah. Lausanne, Elsevier Sequoia, S.A. (*Thin Solid Films*, vol. 53-54, 1978), 1978. Vol. 1, 396 p.; vol. 2, 381 p. Price of two volumes, \$93.38.

Recent advances in protective metallurgical coatings for a variety of low-wear, low-corrosion, and high-temperature applications are discussed. Attention is focused on characterization of coatings, surface cleaning techniques, metallurgical aspects of microelectronics, coatings for gas turbine applications, and coatings for friction and wear. Other problem areas of interest include advances in PVD technology, refractory compound coatings, coatings for solar energy applications, and metal and alloy coatings (structure, properties and applications). The information presented serves as a sound basis for further developments.

S.D.

A79-31969 Selective-black absorbers using sputtered cermet films. J. C. C. Fan (MIT, Lexington, Mass.). In: Metallurgical coatings 1978; Proceedings of the Fifth International Conference, San Francisco, Calif., April 3-7, 1978. Volume 2. Lausanne, Elsevier Sequoia, S. A., 1978, p. 139-148. 14 refs.

USAF-sponsored research.

Selective-black absorbers have high solar absorptivity and low infrared emissivity. Excellent selective-black absorbers are prepared by using RF sputtering to deposit MgO-Au and Cr<sub>2</sub>O<sub>3</sub>-Cr cermet films, which are highly absorbing in the solar spectrum and highly transparent in the infrared, on metal substrates. Both types of films are found to consist of individual crystallites less than 200 Å in size. Absorbers with solar absorptivity of over 0.9 and infrared emissivity of less than 0.1 have been prepared by depositing films of 75 vol% MgO-25 vol% Au on molybdenum-coated stainless steel. These absorbers are stable in air up to 400 °C. Absorbers with similar optical properties have been obtained by depositing films of 71 vol% Cr<sub>2</sub>O<sub>3</sub>-29 vol% Cr on nickel-coated stainless steel, provided that

these films are covered with a Cr<sub>2</sub>O<sub>3</sub> antireflection coating. These absorbers are stable in air up to 300 °C. Computer calculations indicate that even better selective properties can be obtained by using Cr<sub>2</sub>O<sub>3</sub>-Cr films with a graded composition profile rather than a discrete Cr<sub>2</sub>O<sub>3</sub> coating.

(Author)

A79-31970 Black germanium solar selective absorber surfaces. L. R. Gilbert, R. Messler, and R. Roy (Pennsylvania State University, University Park, Pa.). In: Metallurgical coatings 1978; Proceedings of the Fifth International Conference, San Francisco, Calif., April 3-7, 1978. Volume 2. Lausanne, Elsevier Sequoia, S. A., 1978, p. 149-157. 19 refs.

Semiconductor films with an appropriate bandgap (approximately 0.5-1.25 eV) have a high absorption coefficient in the solar spectral region and high transmission in the IR thermal emission region and thus make nearly ideal selective absorbers when coated on polished metal surfaces with low IR emittance. However, owing to their high refractive index, semiconductor films have high reflectance (approximately 45%) which limits their total solar absorption. It is shown that by controlling the sputtering preparation conditions of noncrystalline germanium films the surface microstructure can be drastically altered by simply etching in 30% H<sub>2</sub>O<sub>2</sub>. The resulting surface has a total reflectance of less than 3% in the solar spectrum. This flat-back surface appearance is shown to be due to a dense array of aligned needle-like protrusions which have an extremely high aspect ratio and both a cross-sectional area and a separation between needles of the order of the wavelength of solar radiation. (Author)

A79-32103 # The formulation of the wall stabilization problem of an axisymmetrical toroidal sharp-boundary plasma with a horizontally elongated noncircular cross section. T. Honma, I. Kaji, M. Seki (Hokkaido University, Sapporo, Japan), and M. Kito (Ministry of International Trade and Industry, Electrotechnical Laboratory, Tokyo, Japan). *Hokkaido University, Faculty of Engineering, Bulletin*, no. 93, 1979, p. 57-67. 10 refs.

The problem of the stability of an axisymmetric toroidal sharp-boundary plasma in a perfectly conducting toroidal wall. The cross section of the plasma is assumed to be horizontally elongated. The argument of the Wangerin functions is given exactly by both the aspect ratio and the elongation ratio of the toroidal geometry. Flat ring cyclide coordinates are introduced, and the equilibrium of the plasma in the flat-ring cyclide coordinates is studied under the assumption of uniform pressure confined only by surface currents. Critical poloidal beta's are obtained.

P.T.H.

A79-32105 Development of the combustion chamber of an experimental MHD generator. Ia. S. Zholudov (Akademii Nauk Ukrainskoi SSR, Institut Elektrodinamiki, Kiev, Ukrainian SSR). (*Teploenergetika*, Aug. 1978, p. 45-48.) *Thermal Engineering*, vol. 25, no. 8, 1978, p. 21-24. 8 refs. Translation.

The requirement placed on the combustion chamber of an MHD generator operating with nonpreheated fuel are formulated. A combustion chamber designed for gaseous fuel, which meets the formulated requirements is described. Particular attention is given to design solutions leading to an ordered spatial structure of the flow and a drastic decrease in fluctuations.

V.P.

A79-32139 Solar energy in developing countries: An overview and buyers' guide for solar scientists and engineers. A. Eggers-Lura (European Helio Centre, Gentofte, Denmark). Oxford, Pergamon Press, Ltd. (Pergamon European Heliosciences. Volume 1), 1979. 212 p. 1500 refs. \$40.

The book is an overview and buyers' guide for solar scientists and engineers on solar energy in developing countries. General information on solar activities of relevance for the developing countries is given, along with a review of the state of the art of solar energy applications in developing countries. Attention is directed to solar R&D work in these countries. Also provided is information on sources of literature, hardware and equipment, along with a detailed

**A79-32194**

bibliography (mostly with abstracts) that comprises about 2000 entries.

S.D.

**A79-32194 Solar energy - Four sites demonstrate potential.** T. Collins. *IEEE Spectrum*, vol. 16, Apr. 1979, p. 60-65.

Four solar energy demonstration units are described: a space-heating and hot-water facility for a school gymnasium in Iowa; a hot-water system retrofitted to a large commercial laundry in California; a system providing space heating and cooling to a small, two-story office building in Florida; and a direct-gain type passive space heating facility for a warehouse in New Hampshire. Although none of the systems discussed here shows a high degree of cost-effectiveness, production-line manufacturing and mass marketing should help to cut costs. At present, the New Hampshire system would be competitive with electricity priced at 4.3 cents/kWh.

J.M.B.

## STAR ENTRIES

**N79-16932#** Centre National d'Etudes Spatiales, Toulouse (France).

### HIGH ACCURACY OFF-SHORE POSITION FINDING USING THE GEOLE SATELLITE BASED SYSTEM

Jean-Claude Husson and Jean Saint-Etienne Apr. 1977 16 p  
Avail: NTIS HC A02/MF A01

Market studies conducted in 1971 and 1974 show that the number of potential users for high-precision position-fixing systems (i.e. ones offering an open sea accuracy of 100 to 200 m) was limited. The total number of ships requiring such services in the early 1990's can be estimated at 400. These ships will be highly specialized and well equipped; on board equipment will clearly include sophisticated dead reckoning systems (Doppler sonar, inertial unit, etc.) and computers. The GEOLE was designed as a means of periodically updating dead reckoning calculations performed onboard ships. To provide updating every 2 hours would require 4 satellites, each weighing 250 kg. These would be placed in orbits at an altitude of 1500 km inclined at 75 deg to the equator, with the four ascending nodes separated from one another by 45 deg of longitude. J.A.M.

**N79-15961#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

### THE ROTARY COMBUSTION ENGINE: A CANDIDATE FOR GENERAL AVIATION

1978 190 p refs Symp. held at Cleveland, Ohio, 28 Feb. 1978  
(NASA-CP-2067: E-9800) Avail: NTIS HC A09/MF A01 CSCL 21A

The state of development of the rotary combustion engine is discussed. The nonturbine engine research programs for general aviation and future requirements for general aviation powerplants are emphasized.

**N79-15963#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

### GENERAL AVIATION ENERGY-CONSERVATION RESEARCH PROGRAMS

Edward A. Willis *In its* The Rotary Combust. Engine 1978 p 13-35 refs  
Avail: NTIS HC A09/MF A01 CSCL 21A

A review is presented of nonturbine general aviation engine programs underway at the NASA-Lewis Research Center. The program encompasses conventional, lightweight diesel, and rotary engines. Its three major thrusts are: (1) reduced SFC's; (2) improved fuel tolerance; and (3) reducing emissions. Current and planned future programs in such areas as lean operation, improved fuel management, advanced cooling techniques, and advanced engine concepts, are described. These are expected to lay the technology base, by the mid to latter 1980's, for engines whose total fuel costs are as much as 30% lower than today's conventional engines. J.M.S.

**N79-15964#** Toyo Kogyo Co. Ltd., Hiroshima (Japan). DEVELOPMENT STATUS OF ROTARY ENGINE AT TOYO KOGYO

Kenichi Yamamoto *In NASA*. Lewis Res. Center The Rotary Combust. Engine 1978 p 37-84

Avail: NTIS HC A09/MF A01 CSCL 21A

Progress in the development of rotary engines which use a thermal reactor as the primary part of the exhaust emission control system is reviewed. Possibilities of further improvements in fuel economy of future rotary engines are indicated. J.M.S.

**N79-15965#** Audi NSU Auto Union A.G., Neckarsulm (West Germany).

### UPDATE OF DEVELOPMENT ON THE NEW AUDI NSU ROTARY ENGINE GENERATION

Richard vanBasshuysen *In NASA*. Lewis Res. Center The Rotary Combust. Engine 1978 85-107

Avail: NTIS HC A09/MF A01 CSCL 21A

Rotary engines with a chamber volume of 750 cc as a two rotor automotive powerplant, called KKM 871 are described. This engine is compared to a 3 liter or 183 cubic inch, six-cylinder reciprocating engine. Emphasis is placed on exhaust emission control and fuel economy. J.M.S.

**N79-15966#** Audi NSU Auto Union A.G., Neckarsulm (West Germany).

### REVIEW OF THE RHEIN-FLUGZEUGBAU WANKEL POWERED AIRCRAFT PROGRAM

Manfred Riethmueller *In NASA*. Lewis Res. Center The Rotary Combust. Engine 1978 p 109-122

Avail: NTIS HC A09/MF A01 CSCL 21A

The development of light aircraft with special emphasis on modern propulsion systems and production is discussed in terms of the application of rotary engines to aircraft. Emphasis is placed on the integrated ducted-fan propulsion system using rotary engines. J.M.S.

**N79-15967#** Curtiss-Wright Corp., Wood-Ridge, N.J.

### ROTARY ENGINE DEVELOPMENTS AT CURTISS-WRIGHT OVER THE PAST 20 YEARS AND REVIEW OF GENERAL AVIATION ENGINE POTENTIAL

Charles Jones *In NASA*. Lewis Res. Center The Rotary Combust. Engine 1978 p 123-174 refs

Avail: NTIS HC A09/MF A01 CSCL 21A

The development of the rotary engine as a viable power plant capable of wide application is reviewed. Research results on the stratified charge engine with direct chamber injection are included. Emission control, reduced fuel consumption, and low noise level are among the factors discussed in terms of using the rotary engine in general aviation aircraft. J.M.S.

**N79-15968#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

### ENGINE REQUIREMENTS FOR FUTURE GENERAL AVIATION AIRCRAFT

Joseph W. Stickle *In NASA*. Lewis Res. Center The Rotary Combust. Engine 1978 p 175-186

Avail: NTIS HC A09/MF A01 CSCL 21A

The market place is examined for general aviation aircraft into the 1980's. The visible constraints that engine manufacturers must face regardless of the type of cycle are indicated. J.M.S.

**N79-16036#** Rockwell International Corp., Downey, Calif. Space Div.

### SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY. VOLUME 1: EXECUTIVE SUMMARY

#### Final Report

G. Hanley Apr. 1978 88 p 7 Vol.

(Contract NAS8-32475)

(NASA-CR-150700: SD-78-AP-0023-1-Vol-1) Avail: NTIS HC A05/MF A01 CSCL 228

The evolution of a total satellite power is described as well as major subsystem alternatives. Trade study results are given for satellite concepts, ground receiving antennas, satellite construction sites, and transportation. Point design definition, end-to-end analysis, and programmatic are covered. The GaIAAs

N79-16037

photovoltaic concept is recommended as the current preliminary baseline satellite concept with silicon photovoltaic and Rankine cycle solar-thermal concepts as viable alternatives. Geosynchronous orbit is preferred for the construction of the satellite. A horizontal takeoff and landing air breathing rocket HLLV concept is preferred for earth-to-LEO transportation, with vertical takeoff options as viable alternatives. An argon electric orbit transfer vehicle is preferred for cargo transport from LEO and GEO orbit, and a chemical LH<sub>2</sub>/LO<sub>2</sub>, two-stage orbit transfer vehicle is recommended for crew transport. A stripline rectenna array is the current preferred concept.

A.R.H.

N79-16037\*# Rockwell International Corp., Downey, Calif. Space Div.

**SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY. VOLUME 2: SPS SYSTEM REQUIREMENTS**

**Final Report**

G. Hanley Apr. 1978 93 p. 7 Vol.

(Contract NAS8-32475)

(NASA-CR-150681; SD-78-AP-0023-2-Vol-2) Avail: NTIS HC A05/MF A01 CSCL 22B

Collected data reflected the level of definition resulting from the evaluation of a broad spectrum of SPS (satellite power systems) concepts. As the various concepts matured, these requirements were updated to reflect the requirements identified for the projected satellite system/subsystem point design(s). The study established several candidate concepts which were presented to provide a basis for the selection of one or two approaches that would be given a more comprehensive examination. The two selected concepts were expanded and constitute the selected system point designs. The identified system/subsystem requirements was emphasized and information on the selected point design was provided.

Author

N79-16039\*# Rensselaer Polytechnic Inst., Troy, N.Y. Dept. of Electrical and Systems Engineering.

**SOLAR POWER SATELLITE RECTENNA DESIGN STUDY: DIRECTIONAL RECEIVING ELEMENTS AND PARALLEL-SERIES COMBINING ANALYSIS** Final Report, 3 Feb. 1978 - 1 Dec. 1978

Ronald J. Gutmann and Jose M. Borrego Dec. 1978 123 p refs

(Contract NAS9-15453)

(NASA-CR-151866) Avail: NTIS HC A06/MF A01 CSCL 22B

Rectenna conversion efficiencies (RF to dc) approximating 85 percent were demonstrated on a small scale, clearly indicating the feasibility and potential of efficiency of microwave power to dc. The overall cost estimates of the solar power satellite indicate that the baseline rectenna subsystem will be between 25 to 40 percent of the system cost. The directional receiving elements and element extensions were studied, along with power combining evaluation and evaluation extensions.

J.A.M.

N79-16057\*# Grumman Aerospace Corp., Bethpage, N.Y. MANNED REMOTE WORK STATION DEVELOPMENT ARTICLE Interim Review No. 2

8 Nov. 1978 260 p

(Grant NAS9-15507)

(NASA-CR-151871; NSS-MR-RP-011) Avail: NTIS HC A12/MF A01 CSCL 22B

Flight article and associated design concepts are evaluated to meet fundamental requirements of a universal crew cabin to be used as a construction cherrypicker, a space crane turret, a railed work station, or a free flyer. Key technology developments are embodied into a simulation program. A schedule and simulation test plan matrix is given for the open cabin cherry picker. A.R.H.

N79-16135 West Virginia Univ., Morgantown. THERMOELASTIC SOLUTIONS FOR IN-SITU GASIFICATION OF COAL Ph.D. Thesis

Hsin-Fuh Wang 1978 250 p

Avail: Univ. Microfilms Order No. 7900893

Linear thermoelastic analyses of structural models associated with underground coal gasification (UCG) are conducted. Idealized crack and cavity configurations simulating the Longwall Generator concept and linked vertical wells concept of UCG are studied by deriving closed form solutions. The relevance of the proposed models and their general applications are provided. Four different isotropic, homogeneous thermoelastic models with steady-state heat conduction and prescribed constant temperature boundary conditions at the crack or cavity surface are investigated. The results provide fundamental data for the possible interpretation of cavity configurations, roof stability and related information. Research indicates that the thermomechanical responses are important in the consideration of UCG processes.

Dissert. Abstr.

N79-16138\*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

**EFFECT OF BROADENED-SPECIFICATION FUELS ON AIRCRAFT ENGINES AND FUEL SYSTEMS**

R. A. Rudy 1979 25 p refs To be presented at the 4th Intern. Symp. on Airbreathing Eng., Lake Buena Vista, Fla., 1-6 Apr. 1979; sponsored by AIAA

(NASA-TM-79086; E-9898) Avail: NTIS HC A02/MF A01 CSCL 21D

A wide variety of studies on the potential effects of broadened-specification fuels on future aircraft engines and fuel systems are summarized. The compositions and characteristics of aircraft fuels that may be derived from current and future crude-oil sources are described, and the most critical properties that may effect aircraft engines and fuel systems are identified and discussed. The problems that are most likely to be encountered because of changes in selected fuel properties are explored; and the related effects on engine performance, component durability and maintenance, and aircraft fuel-system performance are examined. The ability of current technology to accept possible future fuel specification changes is assessed and selected technological advances that can reduce the severity of the potential problems are illustrated.

A.R.H.

N79-16138# Princeton Univ., N.J. Guggenheim Labs. FUNDAMENTAL COMBUSTION STUDIES OF EMULSIFIED FUELS FOR DIESEL APPLICATIONS Final Report, 1 Jul. 1974 - 30 Sep. 1977

F. L. Dryer and I. Glassman Dec. 1977 233 p refs (Grant NSF AER-76-08210) (PB-287386/7; NSF/AER-76-08210) Avail: NTIS HC A11/MF A01 CSCL 21B

The combustion characteristics of water-in-fuel emulsions were defined and the relationship of emulsion characteristics to the micro-explosion phenomena were examined. Research encompassed emulsion formation techniques, physical characteristics, emulsion coalescence kinetics (stability), single suspended free droplet combustion, spray characterization, and nucleate vaporization (of the internal phase) prediction. Results were used to critically evaluate published practical results, predict favorable applications for emulsion combustion, and guide full scale implementation research and development.

GRA

N79-16139# Versar, Inc., Springfield, Va. ASSESSMENT OF COAL CLEANING TECHNOLOGY Annual Report, Jan. 1977 - Jan. 1978

Lee C. McCandless and Robert B. Shaver Jul. 1978 164 p refs

(Contract EPA-68-02-2199) (PB-287091/3; EPA-600/7-78-150; AR-1) Avail: NTIS HC A08/MF A01 CSCL 08I

Topics of discussion include: (1) washability characteristics of coal, with emphasis on the correlations of various washability parameters; (2) current technology on coal comminution and gravity separation processes; (3) eleven major chemical coal cleaning processes; (4) current technology on mechanical and thermal drying and oil agglomeration; (5) slurry sampling techniques; and (6) coal preparation requirements for synthetic fuel conversion processes, in terms of particle size, moisture, ash, sulfur, and heating value. In addition, coal preparation requirements for 6 high-Btu gasification processes, 13 low-Btu

gasification processes, and 5 liquefaction processes are summarized. GRA

**N79-16140#** University of Southern California, Los Angeles, Inst. for Marine and Coastal Studies.

**COOKING WITH OFFSHORE OIL: A HANDBOOK FOR CALIFORNIA LOCAL GOVERNMENT**

Martin Chorich Aug. 1978 243 p refs Sponsored in part by US Civil Service Commission (Grant NOAA-04-7-158-44113) (PB-288656/2; USCSG-AS-01-78; NOAA-78100601) Avail: NTIS HC A11/MF A01 CSCL 10A

This handbook includes: (1) a brief introduction to the leasing process and outer continental shelf (OCS) development issues; (2) an OCS issues chart, summarizing and bringing together the material presented; (3) dissection of development issues and recommendations for planning recipes; (4) policy options open to local governments; (5) recommendations by policy makers involved in the OCS development process concerning promising courses of action, and (6) the appendices and bibliographic references. The appendices contain the correspondences local governments have used to respond to OCS development. GRA

**N79-16144#** National Technical Information Service, Springfield, Va.

**CRYOGENIC REFRIGERATION, VOLUME 2. A BIBLIOGRAPHY WITH ABSTRACTS Progress Report, 1973 - Oct. 1977**

William E. Reed Dec. 1978 236 p (NTIS/PS-78/1261/3). Avail: NTIS HC \$28.00/MF \$28.00 CSCL 13A

Cryogenic cooling of electronic equipment, infrared equipment, infrared equipment, cryogenic storage vessels, magnetohydrodynamic generators, and superconducting magnets, coils, rotating machinery, and transmission lines is reported. Marine refrigeration of liquefied natural gas, cryogenic heat pipes, cryogenic heat transfer, and space applications are studied. Methods investigated include adiabatic demagnetization, electrocaloric effect, Joule-Thompson effect, thermoelectric cooling, and Crayton, Claude, Gifford-McMahon, Sterling, and Vuilleumier cycles. This updated bibliography contains 229 abstracts, none of which are new entries to the previous edition. GRA

**N79-16145#** National Technical Information Service, Springfield, Va.

**CRYOGENIC REFRIGERATION, VOLUME 3. A BIBLIOGRAPHY WITH ABSTRACTS Progress Report, Nov. 1977 - Nov. 1978**

William E. Reed Nov. 1978 84 p Supersedes NTIS/PS-77/1158; NTIS/PS-76/0871; NTIS/PS-75/826 (NTIS/PS-78/1262/1; NTIS/PS-77/1158; NTIS/PS-76/0871; NTIS/PS-75/826). Avail: NTIS HC \$28.00/MF \$28.00 CSCL 13A

Cryogenic cooling of electronic equipment, infrared equipment, cryogenic storage vessels, magnetohydrodynamic generators, and superconducting magnets, coils, rotating machinery, and transmission lines is reported. Marine refrigeration of liquefied natural gas, cryogenic heat pipes, cryogenic heat transfer, and space applications are studied. Methods investigated include adiabatic demagnetization, electrocaloric effect, Joule-Thompson effect, thermoelectric cooling, and Crayton, Claude, Gifford-McMahon, Sterling, and Vuilleumier cycles. This updated bibliography contains 77 abstracts, all of which are new entries to the previous edition. GRA

**N79-16148#** AIA Research Corp., Washington, D. C. **PHASE ONE/BASE DATA FOR THE DEVELOPMENT OF ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS: DATA ANALYSIS**

Jan. 1978 218 p ref Sponsored in part by DOE (Contract HUD-H-2689) (PB-286901/4; HUD-0000193) Avail: NTIS HC A10/MF A01 CSCL 13A

Features of the analysis method used to measure the designed energy performance of buildings are outlined. Major objectives of the analysis were to estimate the mean and 20th, 50th, and 80th percentiles for annual building energy performance figures in various climatic regions to estimate the energy performance of all buildings selected for inclusion in the sample; and to

estimate building energy performance by major component of energy and use. Criteria for the selection of an analysis method were devised, and a computerized technique was selected that calculates hourly zone solar and transmission loads for the year using input design loads. GRA

**N79-16150#** AIA Research Corp., Washington, D. C.

**PHASE ONE/BASE DATA FOR THE DEVELOPMENT OF ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS: SAMPLE DESIGN**

30 Jan. 1978 107 p Prepared in cooperation with DOE, Washington, D.C. (Contract HUD-H-2689) (PB-286903/0; HUD-0000195) Avail: NTIS HC A06/MF A01 CSCL 13A

The sample design employed in a 1977 building energy performance survey for the Department of Housing and Urban Development is discussed. A sample of 37 standard metropolitan statistical areas (SMSA's) was selected from all SMSA's with a population over 250,000. The selection was simple random within strata defined by the population size of each SMSA, heating degree days of each SMSA, and cooling hours of each SMA. This sample of SMSA's was used to select a secondstage sample of buildings for 12 building types covered by the survey. The basic design requirement was to provide estimates of the 80th percentile of the distribution of energy per square foot per year in buildings for combinations of the 12 building types of 8 climatic zones. GRA

**N79-16210** Texas Univ. at Austin.

**ENERGY AND ECONOMIC ANALYSIS OF INDUSTRIAL PROCESS HEAT RECOVERY WITH HEAT PUMPS**

Ph.D. Thesis

Alfredo Heli Urdanetta-Bohorquez 1978 280 p (encls.) Avail: Univ. Microfilms Order No. 7900645

A two-stream process scheme is considered as the basic heat pump heat recovery model around which the energy/economic analysis is developed. An algorithm is implemented to search for the heat pump cycle operational conditions that minimize energy consumption and maximize economic profitability. The measure of energy performance is the ratio of primary energy consumption by the heat pump system to primary energy consumption by the reference (no heat recovery) process configuration. The measure of economic profitability is an internal rate-of-return obtained from an incremental aftertax present worth analysis of the heat pump. Two economic scenarios are modeled to reflect future energy costs: a government regulated energy market and a free energy market option. Two investment strategies are modeled to analyze the incorporation of heat pumps within a process configuration: new design and retrofit. A food processing industry example and a petroleum refinery example are parametrically analyzed.

Dissert. Abstr.

**N79-16260#** Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Geneve (Belgium).

**CLOSED CYCLE GAS TURBINES, VOLUME 1**

1977 381 p refs Proc. of Lectures held on 9-13 May, 1977 2 Vol.

(VKI-LS-100-Vol-1) Avail: NTIS HC A16/MF A01; Von Karman Inst. for Fluid Dyn. BF 4.500

High power and low power closed cycle turbines are studied. The following topics are discussed: (1) large closed cycle gas turbine plants; (2) the use of liquid natural gas as heat sink for power cycles; (3) the development of thermal prime movers for heat pump drive; and (4) dissociating gases of working fluids.

**N79-16261#** General Atomic Co., San Diego, Calif.

**LARGE CLOSED-CYCLE GAS TURBINE PLANT**

Colin F. McDonald In Von Karman Inst. for Fluid Dyn. Closed Cycle Gas Turbine, Vol. 1 1977 265 p refs

(Contract E(04-3)-167; Gen. Atomic Proj. 2095; Gen. Atomic Proj. 4351; Gen. Atomic Proj. 3227)

(GA-A-14311) Copyright. Avail: NTIS HC A16/MF A01; Von Karman Inst. for Fluid Dyn. BF 4.500

N79-16262

A plant with a high temperature gas cooled reactor (HTGR) as the heat source is designed. The design evolution for a large nuclear closed-cycle gas turbine power plant is summarized. A background on closed-cycle gas turbines, the incentives for the GT-HTGR, cycle selection, plant configuration studies, performance, selection of a reference plant design, component design activities, and a description of the waste heat binary power plant are presented. Development and testing alternatives, and related international programs in the closed-cycle gas turbine field are included.

S.E.S.

**N79-16262# Politecnico di Milano (Italy). Ist. di Macchine. THE USE OF LIQUID NATURAL GAS AS HEAT SINK FOR POWER CYCLES**

G. Angelino /n Von Karman Inst. for Fluid Dyn. Closed Cycle Gas Turbines, Vol. 1 1977 40 p refs

Copyright. Avail: NTIS HC A16/MF A01; Von Karman Inst. for Fluid Dyn. BF 4.500

The thermodynamics of power cycles employing LNG as heat sink is discussed. Condensation cycles in simple or in elaborate versions, employing non-toxic, non-flammable, inert organic working fluids (CF4, C2F6, CHF3, C3F8), yield the best overall performance for LNG vaporization at subcritical pressure. For supercritical vaporization, heat rejection from Brayton cycles naturally fits heat sink thermal characteristics, which results in a particularly high efficiency for closed gas cycles. If only a fraction of the cooling capability of LNG is devoted to power uses, condensation cycles are superior to gas cycles even at supercritical LNG pressures. Under the most favourable circumstances, gas cycles achieve efficiencies of around 60 percent, while some elaborate condensation cycles attain the 70 percent level.

Author

5 Jln:

not specified

**N79-16263# Politecnico di Milano (Italy). Ist. di Macchine. DEVELOPMENT OF THERMAL PRIME MOVERS FOR HEAT PUMP DRIVE**

G. Angelino /n Von Karman Inst. for Fluid Dyn. Closed Cycle Gas Turbines, Vol. 1 1977 25 p refs

Copyright. Avail: NTIS HC A16/MF A01; Von Karman Inst. for Fluid Dyn. BF 4.500

The energy savings connected with low grade heat generation by means of heat pumps powered by thermal engines whose waste heat is recovered are illustrated. The performance of the system is compared with that of alternate methods of low temperature heat production. The characteristics of thermal prime movers adequate for the proposed application which are either available or under development are reviewed. Particular attention is devoted to organic working fluid cycles whose basic thermodynamics and main technical features are discussed. Results are reported of an example of technical and economical analysis relating to the heating of a large building by means of a thermal engine-heat pump system.

Author

**N79-16268# Politecnico di Milano (Italy). Ist. di Macchine. POWER CYCLES AND WORKING FLUIDS FOR LOW TEMPERATURE HEAT SOURCES**

E. Macchi /n Von Karman Inst. for Fluid Dyn. Closed Cycle Gas Turbines, Vol 2 1977 44 p refs

Copyright. Avail: NTIS HC A12/MF A01; Von Karman Inst. for Fluid Dyn. BF 4.500

By making use of proper working fluids and cycles, mechanical power can be economically obtained by relatively low-temperature heat sources. Some possible applications for these engines are reviewed. Choice criteria of working fluids and thermodynamic cycles for various heat sources temperatures and power outputs are discussed. Advantages of organic fluids versus steam are evidenced, both from thermodynamic and expander design points of view. The possibility of obtaining efficient turbines even at very low power levels by making use of low condensation pressure is discussed. Experimental results of a recently developed 3 kW prototype engine for solar power application, operating between 75 and 30 C are presented.

G.Y.

**N79-16342# Federal-State Land Use Planning Commission for Alaska, Anchorage.**

**NORTHERN ALASKA HYDROCARBON RESOURCES**

Jerry D. Kreitner May 1978 79 p refs  
(PB-287394/1; FSLUPCA-34) Avail: NTIS HC A05/MF A01 CSCL 10A

The private, federal, and state oil and gas initiatives in Northern Alaska over the past 35 years are brought together. It treats Northern Alaska oil and gas provinces as a planning unit, rather than using the classic (private, state, etc.) divisions. GRA

**N79-16345 City Univ. of New York.**

**MODELLING AND CONTROL OF A FLUIDIZED BED GASIFIER Ph.D. Thesis**

Moshe Kutten 1978 182 p

Avail: Univ. Microfilms Order No. 7900791

An evaluation of the steady state and the dynamic behavior of an air blown fluidized bed coal gasifier to producing low BTU gas is presented. A simplified model of such a gasifier is presented. It is shown that the steady state range of control can be sometimes considerably smaller than indicated by purely hydrodynamic consideration, as lower flow rates can lead to higher conversions. The dynamic behavior shows a short time response dominated by the thermal inertia of the coal bed and a long time response, which is a function of the adjustment of the bed ash content to different flow rates. Both the dynamic and steady state features of the system strongly depend on the design of the system. The results of the thesis illustrates the type of problems that may be encountered and suggests some potential solutions.

Dissert. Abstr.

**N79-16346 California Univ., Los Angeles.**

**AEROELASTIC RESPONSE AND STABILITY OF A COUPLED ROTOR/SUPPORT SYSTEM WITH APPLICATION TO LARGE HORIZONTAL AXIS WITH TURBINES Ph.D. Thesis**

William Warmbrodt 1978 326 p refs

Avail: Univ. Microfilms Order No.:7901415

The derivation of a governing set of nonlinear equations of motion for a coupled rotor/support system is presented. The model includes an n-bladed rotor with elastic blade flap and lead-lag degrees of freedom. The blades can have precone, pitch bearing offset, built-in twist, and cross sectional offsets between the aerodynamic center, the center of mass, and the elastic axis. The rotor support has two translational degrees of freedom and three rotational degrees of freedom. The general set of equations were specialized to analytically represent a coupled n-bladed rotor/fuselage model of a helicopter in hover or forward flight. The fuselage was modeled as a rigid body. Inertia, aerodynamic, structural, and gravitational loads are considered. Wind gusts in all three directions was included. Rotor/fuselage matching was performed by requiring force and moment equilibrium between the rotor and the fuselage. Dissert. Abstr.

**N79-16349 Nebraska Univ. - Lincoln.**

**PARAMETER ESTIMATION AND VALIDATION OF A SOLAR ASSISTED HEAT PUMP MODEL Ph.D. Thesis**

Bing Chen 1978 235 p

Avail: Univ. Microfilms Order No. 7900300

A methodology is described which employs parameter estimation techniques for a model that accurately simulates the performance of an existing solar assisted heat pump structure. The model will then serve as the basis for the future application of various techniques to determine optimal control strategies, to minimize component sizing and to evaluate the performance (by simulation) of alternate solar energy systems. The model described in this thesis incorporates onsite weather data, mechanical system characteristics, heat flow dynamics, and control logic. A set of difference equations is developed. A weighted least squares algorithm is employed to estimate the model's parameters. The model is used with a known weather profile to predict heat pump performance for comparison with actual performance data.

Dissert. Abstr.

**N79-16361\*** Gnostic Concepts, Inc., Menlo Park, Calif.  
**INDUSTRIALIZATION STUDY, PHASE 2 Final Report**  
 5 Jan. 1979 129 p refs Prepared for JPL and DOE  
 (Contracts NAS7-100; JPL-954899)  
 (NASA-CR-158015) Avail: NTIS HC A07/MF A01 CSCL 10A

The potentials and requirements of advanced photovoltaic technologies still in their early developmental stages were evaluated and compared to the present day single crystal silicon wafer technology and to each other. The major areas of consideration include polycrystalline and amorphous silicon, single crystal and polycrystalline gallium arsenide, and single crystal and polycrystalline cadmium sulfide. A rank ordering of the advanced technologies is provided. The various ranking schemes were based upon present-day efficiency levels, their stability and long-term reliability prospects, material availability, capital investments both at the laboratory and production level, and associated variable costs. An estimate of the timing of the possible readiness of these advanced technologies for technology development programs and industrialization is presented along with a set of recommended government actions concerning the various advanced technologies. A.R.H.

**N79-16362\*** Committee on Interstate and Foreign Commerce (U. S. House).  
**ENERGY AND THE ECONOMY: THE ECONOMIC IMPACT OF ALTERNATIVE ENERGY SUPPLY-DEMAND ASSUMPTIONS**

Washington GPO 1978 34 p refs Study for Subcomm. on Energy and Power of the Comm. on Interstate and Foreign Commerce, Apr. 1978 Prepared by Library of Congr., Congressional Res. Service  
 (H-Print-95-51; GPO-22-673) Avail: Subcomm. on Energy and Power

Several energy scenarios were developed and an attempt to measure the impact of these on the U.S. economy is made. The energy scenarios are studied as cases and include: base case; conservation case; high electric case; high oil case; and some caveats. The economic impacts studied are: employment and unemployment; inflation; investment; personal consumption; and foreign trade. Figures and data tables are presented. G.Y.

**N79-16363\*** Committee on Interstate and Foreign Commerce (U. S. House).  
**INDUSTRIAL ENERGY CONSERVATION**

Washington GPO 1978 171 p refs Hearings on H.R. 8985 before the Subcomm. on Energy and Power of the Comm. on Interstate and Foreign Commerce, 95th Congr., 1st Sess., 27 and 29 Sep. 1977  
 (GPO-24-067) Avail: Subcomm. on Energy and Power

A Bill, H.R. 8985, is introduced which requires the Department of Energy to establish test procedures, labeling rules, and energy efficiency standards for electric motors and pumps, and for other purposes. Representatives from Government and industry give testimony on the proposed Bill. G.Y.

**N79-16365\*** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.  
**POWER TRAIN ANALYSIS FOR THE DOE/NASA 100-kW WIND TURBINE GENERATOR Final Report**  
 Robert C. Seidel, Harold Gold, and Leon M. Wenzel Oct. 1978 57 p refs Prepared for DOE  
 (Contract E(49-26)-1028)  
 (NASA-TM-78997; DOE/NASA/1028-78/19; E-9413) Avail: NTIS HC A04/MF A01 CSCL 10A

Progress in explaining variations of power experienced in the on-line operation of a 100 kW experimental wind turbine-generator is reported. Data are presented that show the oscillations tend to be characteristic of a wind-driven synchronous generator because of low torsional damping in the power train, resonances of its large structure, and excitation by unsteady and nonuniform wind flow. The report includes dynamic analysis of the drive-train torsion, the generator, passive driveline damping, and active pitch control as well as correlation with

experimental recordings. The analysis assumes one machine on an infinite bus with constant generator-field excitation. Author

**N79-16367\*** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.  
**AN OPERATING 200-kW HORIZONTAL AXIS WIND TURBINE**  
 Charles L. Hunnicutt (Lockheed Aircraft Service Co., Ontario, Calif.), Bradford Linscott, and Robert A. Wolf 1978 25 p Presented at 23rd Natl. SAMPE Symp. and Exhibition, Anaheim, Calif., 2-4 May 1978  
 (Contract E(49-26)-1004)  
 (NASA-TM-79034; E-9833) Avail: NTIS HC A02/MF A01 CSCL 10B

The Mod-OA wind turbine blades were rotated for the first time on November 30, 1977, establishing the Mod-OA as the first wind-driven generator in 35 years to be continually tied into an electrical power system which services a community. Tower-mounted equipment and blade structural design and fabrication are discussed. J.M.S.

**N79-16369\*** IBM Federal Systems Div., Huntsville, Ala.  
**SYSTEM DESIGN PACKAGE FOR SIMS PROTOTYPE SYSTEM 3. SOLAR HEATING AND DOMESTIC HOT WATER**  
 Nov. 1978 80 p Prepared for DOE  
 (Contract NAS8-32036)  
 (NASA-CR-150840) Avail: NTIS HC A05/MF A01 CSCL 10B

A collation of documents and drawings are presented that describe a prototype solar heating and hot water system using liquid flat plate collectors and a gas or electric furnace energy subsystem. The system was designed for installation into a single-family dwelling. The description, performance specification, subsystem drawings, verification plan/procedure, and hazard analysis of the system are packaged for evaluation of the system with information sufficient to assemble a similar system. G.Y.

**N79-16380\*** Owens-Illinois, Inc., Toledo, Ohio. Solar Energy Products Group.  
**QUALIFICATION TEST AND ANALYSIS REPORT: SOLAR COLLECTORS**  
 Dec. 1978 147 p Prepared for DOE  
 (Contract NAS8-32259)  
 (NASA-CR-150860) Avail: NTIS HC A07/MF A01 CSCL 10B

Test results show that the Owens-Illinois Sunpak TM Model SEC 601 air-cooled collector meets the national standards and codes as defined in the Subsystem Performance Specification and Verification Plan of NASA/MSFC, dated October 28, 1976. The program calls for the development, fabrication, qualification and delivery of an air-cooled solar collector for solar heating, combined heating and cooling, and/or hot water systems. G.Y.

**N79-16381\*** IBM Federal Systems Div., Huntsville, Ala.  
**SYSTEM DESIGN PACKAGE FOR SIMS PROTOTYPE SYSTEM 4. SOLAR HEATING AND DOMESTIC HOT WATER**  
 Nov. 1978 145 p refs Prepared for DOE  
 (Contract NAS8-32036)  
 (NASA-CR-150839) Avail: NTIS HC A07/MF A01 CSCL 10B

The system consisted of a modular designed prepackaged solar unit, containing solar collectors, a rock storage container, blowers, dampers, ducting, air-to-water heat exchanger, DHW preheat tank, piping, and system controls. The system was designed to be installed adjacent to a small single family dwelling. The description, performance specification, subsystem drawings, verification plan/procedure, and hazard analysis of the system were packaged for evaluation. J.A.M.

**N79-16385\*** Varian Associates, Lexington, Mass. Lexington Vacuum Div.  
**SLICING OF SILICON INTO SHEET MATERIAL: SILICON SHEET GROWTH DEVELOPMENT FOR THE LARGE AREA**

N79-16366

**SILICON SHEET TASK OF THE LOW COST SILICON SOLAR ARRAY PROJECT Quarterly Report, 19 Jun. 1978 - 27 Oct. 1978**

J. R. Fleming 20 Nov. 1978 40 p Sponsored in part by DOE

(Contracts NAS7-100; JPL-954374)

(NASA-CR-158082; JPL-954374-78/1; QR-10) Avail: NTIS HC A03/MF A01 CSCL 10A

The limits of blade tolerance were defined. The standard blades are T-2 thickness tolerance. Good results were obtained by using a slurry fluid consisting of mineral oil and a lubricity additive. Adjustments of the formulation and fine tuning of the cutting process with the new fluid are necessary. Test results and consultation indicate that the blade breakage encountered with water based slurries is unavoidable. Two full capacity (974 wafer) runs were made on the large prototype saw. Both runs resulted in extremely low yield. However, the reasons for the low yield were lack of proper technique rather than problems with machine function. The test on the effect of amount of material etched off of an as-sawn wafer on solar cell efficiency were completed. The results agree with previous work at JPL in that the minimum material removed per side that gives maximum efficiency is on the order of 10 microns. G.Y.

**N79-16366\*# Hughes Research Labs., Malibu, Calif.**

**GeAs SOLAR CELL DEVELOPMENT Quarterly Report, 26 Oct. 1978 - 25 Jan. 1979**

Jan. 1979 .18 p Sponsored by NASA Prepared for JPL

(Contract JPL-955062)

(NASA-CR-158090; QR-3) Avail: NTIS HC A02/MF A01 CSCL 10A

The four (AlGa)As-GaAs solar cells were fabricated and will be delivered for radiation damage testing using 1 MeV electrons. These cells were LPE grown at 700 C for 4 minutes. The junction depth was measured to be 0.3 micron using a secondary electron microscope. The radiation model for the shallow junction cells was verified. Some mesa diodes were also fabricated and will be irradiated along with the cells for parallel evaluations of their electrical characteristics. J.A.M.

**N79-16366\*# Solarex Corp., Rockville, Md.**

**EVALUATION OF THE TECHNICAL FEASIBILITY AND EFFECTIVE COST OF VARIOUS WAFER THICKNESSES FOR THE MANUFACTURE OF SOLAR CELLS Quarterly Progress Report, 15 Jul. 1978 - 30 Sep. 1978**

1978 26 p Sponsored in part by DOE

(Contract JPL-955077; NAS7-100)

(NASA-CR-158095; QPR-1; JPL-955077-78/3) Avail: NTIS HC A03/MF A01 CSCL 10A

Three wafering demonstration runs were completed on the Yasunaga wire saw. Wafer thickness/taper uniformity is excellent. Many small problems were encountered with Yasunaga accessories, slowing the effort. A wafer characterization cycle was defined and will be initiated during the next period. Author

**N79-16366\*# Kayex Corp., Rochester, N. Y.**

**CONTINUOUS CZOCHRALSKI GROWTH: SILICON SHEET GROWTH DEVELOPMENT OF THE LARGE AREA SILICON SHEET TASK OF THE LOW COST SILICON SOLAR ARRAY PROJECT Annual Progress Report, 1 Oct. 1977 - 30 Sep. 1978**

1978 54 p Sponsored by DOE and JPL

(NASA-CR-158096; JPL-954888-78/4; APR-1) Avail: NTIS HC A04/MF A01 CSCL 10A

The primary objective of this contract is to develop equipment and methods for the economic production of single crystal ingot material by the continuous Czochralski (CZ) process. Continuous CZ is defined for the purpose of this work as the growth of at least 100 kilograms of ingot from only one melt container. During the reporting period (October, 1977 - September, 1978), a modified grower was made fully functional and several recharge runs were performed. The largest run lasted 44 hours and over 42 kg of ingot was produced. Little, if any, degradation in efficiency was observed as a result of pulling multiple crystals from one crucible. Solar efficiencies observed were between 9.3 and 10.4% AMO (13.0 and 14.6% AMI) compared to 10.5% (14.7% AMI) for optimum CZ material control samples. Using the SAMICS/PEG

format, economic analysis of continuous CZ suggests that 1986 DoE cost goals can only be met by the growth of large diameter, large mass crystals. Author

**N79-16370\*# Owens-Illinois, Inc., Toledo, Ohio.**

**ANALYSIS AND EXPERIMENTAL TESTS OF A HIGH-PERFORMANCE EVACUATED TUBULAR COLLECTOR**

D. C. Beekley and G. R. Mather, Jr. Dec. 1978 56 p refs Prepared for DOE

(Contract NAS8-32259)

(NASA-CR-150874) Avail: NTIS HC A04/MF A01 CSCL 10B

A high-performance collector based on the use of all-glass, evacuated tubular collector elements is described and analyzed, and supporting experimental data presented. The collector operated with excellent efficiency at temperatures high enough to drive existing air conditioning units, and showed good performance under diffuse light and low insolation conditions. Collector efficiency was insensitive to operating temperature, ambient temperature, and wind speed. In addition, air, as well as liquid, can be used as the heat transfer fluid, with no significant performance penalty. While the equations governing the useful energy produced can be cast in a form similar to that for flat plate collectors, several important parameters were unique in a number of respects. The loss coefficient was unusually low, while the flow factor and effective insolation were unusually high.

Author

**N79-16372\*# Solaron Corp., Denver, Colo.**

**PROTOTYPE SOLAR HEATING AND COOLING SYSTEMS INCLUDING POTABLE HOT WATER Quarterly Reports, Nov. 1976 - Jun. 1977**

Dec. 1978 89 p Prepared for DOE

(Contract NAS8-32249)

(NASA-CR-150861) Avail: NTIS HC A05/MF A01 CSCL 10B

Progress is reviewed in the development, delivery, and support of two prototype solar heating and cooling systems including potable hot water. The system consisted of the following subsystems: collector, auxiliary heating, potable hot water, storage, control, transport, and government-furnished site data acquisition. J.A.M.

**N79-16373\*# Solar Engineering and Equipment Co., Metairie, La.**

**INSTALLATION PACKAGE FOR HYDE MEMORIAL OBSERVATORY, LINCOLN, NEBRASKA**

Dec. 1978 36 p Prepared for DOE

(Contract NAS8-32247)

(NASA-CR-150867) Avail: NTIS HC A03/MF A01 CSCL 10B

Installation information for a solar heating system installed in Hyde Memorial Observatory at Lincoln, Nebraska is presented. This package included a system operation and maintenance manual, hardware brochures, schematics, system operating modes, and drawings. This prototype solar heating system consisted of the following subsystems: solar collector, control, and storage. J.A.M.

**N79-16374\*# Energy Research Corp., Bethel, Conn.**

**FABRICATION AND TESTING OF SILVER-HYDROGEN CELLS**

M. G. Klein Nov. 1978 48 p

(Contract NAS3-19780)

(NASA-CR-159431) Avail: NTIS HC A03/MF A01 CSCL 10B

The development and life testing of single electrode and multi electrode stacks to optimize the individual components and characterize the performance of a silver hydrogen battery system are described. A NASA-developed inorganic separator material was used as the main separator within the cells. Single electrode test cells were cycled at 75% of nominal capacity out through approximately 1,000 cycles in a number of cases where deterioration in performance was observed. This deterioration appears to be a decay in usable capacity of the silver electrode; but the exact mechanism is still unidentified. Twenty ampere-hour boilerplate test cells consisting of a stack of ten silver

electrodes and twenty hydrogen electrodes were cycled also at 75% depth of discharge. The oldest stack achieved 522 stable cycles to the end of the program. Weight analysis of light-weight cells showed that 50 ampere-hour cells with improved components could be capable of as much as 40 watt hours per pound.

A.R.H.

**N79-16377# Burns and McDonnell, Kansas City, Mo.  
ASSESSMENT OF THE POTENTIAL OF SOLAR THERMAL  
SMALL POWER SYSTEMS IN SMALL UTILITIES  
Final Report**

P. Steitz, L. G. Mayo, and S. P. Perkins, Jr. Nov. 1978 222 p refs Prepared for JPL and DOE (Contract JPL-954971)

(NASA-CR-158093; JPL-1060-14; Doc-78-008-4-000) Avail: NTIS HC A10/MF A01 CSCL 10B

The potential economic benefit of small solar thermal electric power systems to small municipal and rural electric utilities is assessed. Five different solar thermal small power system configurations were considered in three different solar thermal technologies. The configurations included: (1) 1 MW, 2 MW, and 10 MW parabolic dish concentrators with a 15 kW heat engine mounted at the focal point of each dish, these systems utilized advanced battery energy storage; (2) a 10 MW system with variable slot concentrators and central steam Rankine energy conversion, this system utilized sensible thermal energy storage; and (3) a 50 MW central receiver system consisting of a field of heliostats concentrating energy on a tower-mounted receiver and a central steam Rankine conversion system, this system also utilized sensible thermal storage. The results are summarized in terms of break-even capital costs. The break-even capital cost was defined as the solar thermal plant capital cost which would have to be achieved in order for the solar thermal plants to penetrate 10 percent of the reference small utility generation mix by the year 2000. The calculated break-even capital costs are presented.

F.O.S.

**N79-16378# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
ANALYSIS AND EVALUATION OF PROCESS AND EQUIPMENT IN TASKS 2 AND 4 OF THE LOW COST SOLAR  
ARRAY PROJECT Quarterly Report, Oct. 1977 - Jan. 1978**

H. Goldman and M. Wolf Aug. 1978 118 p refs Sponsored by NASA and DOE (Contract JPL-954796)

(NASA-CR-158089; DOE/JPL-954796-77/1) Avail: NTIS HC A06/MF A01 CSCL 10A

Several experimental and projected Czochralski crystal growing process methods were studied and compared to available operations and cost-data of recent production Cz-pulling, in order to elucidate the role of the dominant cost contributing factors. From this analysis, it becomes apparent that substantial cost reductions can be realized from technical advancements which fall into four categories: an increase in furnace productivity; the reduction of crucible cost through use of the crucible for the equivalent of multiple state-of-the-art crystals; the combined effect of several smaller technical improvements; and a carry over effect of the expected availability of semiconductor grade polysilicon at greatly reduced prices. A format for techno-economic analysis of solar cell production processes was developed, called the University of Pennsylvania Process Characterization (UPPC) format. The accumulated Cz process data are presented.

Author

**N79-16379# British Aerospace Dynamics Group, Bristol (England). Electronic and Space Systems.  
STUDY ON SOLAR ARRAYS FOR PROGRAMMES LEADING FROM THE EXTENSION OF SPACELAB TOWARDS SPACE  
PLATFORMS Final Report**

P. R. C. Gillett Paris ESA Jun. 1978 98 p (Contract ESA-3404/77-F-HEW(SC)) (ESS/SS-878; ESA-CR(P)-1112) Avail: NTIS HC A05/MF A01

A description of the major requirements of a set of candidate missions is presented and some preliminary solar array designs are given. A development strategy is outlined and the principal areas of new technology identified.

J.M.S.

**N79-16380# Utah State Univ., Logan. Dept. of Sociology, Social Work, and Anthropology.**

**LOCAL PERCEPTIONS OF ENERGY DEVELOPMENT: THE CASE OF THE KAIPAROWITS PLATEAU**

Stephan B. LoveJay, Jeni M. Varady, ed., and Orson L. Anderson, ed. Nov. 1977 79 p refs Sponsored by NSF (PB-287314/9; Bull-62; NSF/RA-770592) Avail: NTIS HC A05/MF A01 CSCL 10A

Proposed energy developments in the predominantly rural Four Corners area of the Southwest are threatening the residents' lifestyles. Data from a simple random sample of household heads in several rural communities in southern Utah and northern Arizona lend support to the proposition that the local citizens are eager to have large-scale energy projects in the Four Corners region. The citizens are willing to exchange elements of their current lifestyles for what are perceived as economic and employment benefits. The analysis presented here suggests that they tend to overemphasize the expected benefits while de-emphasizing, or remaining ignorant of potential disadvantages resulting from such developments. Some explanations for this behavior are examined.

GRA

**N79-16382# Hawaii Univ., Honolulu. Dept. of Meteorology.  
OAHU WIND POWER SURVEY**

Colin S. Ramage, P. Anders Daniels, Thomas A. Schroeder, and Noel J. Thompson May 1977 44 p refs Sponsored in part by Hawaii Natural Energy Inst., Honolulu (Grant NSF AER-76-05596)

(PB-287361/0; UHMET-77-01) Avail: NTIS HC A03/MF A01 CSCL 04A

Avail: NTIS

At seventeen potentially windy sites, calibrated anemometers and wind vanes were installed and recordings made on computer-processable magnetic tape cassettes. From monthly mean wind speeds--normalized by comparing with Honolulu Airport mean winds--it was concluded that about 23 mi/hr represented the highest average annual wind speed likely to be attained on Oahu and that the Koko Head and Kahuku areas gave the most promise for wind energy generation. Diurnal variation of the wind in these areas roughly parallels diurnal variation of electric power demand.

GRA

238-CTIA

**N79-16384# National Bureau of Standards, Washington, D.C.  
Center for Building Technology.**

**THE EFFECTS OF RESOURCE IMPACT FACTORS ON ENERGY CONSERVATION STANDARDS FOR BUILDINGS  
Final Report**

Sep. 1978 61 p refs Sponsored by DOE (PB-286909/7; NBS-BSS-114; LC-78-606072) Avail: NTIS HC A04/MF A01 CSCL 10A

The proper price for energy to be used in the development of optimum (i.e., cost-effective) energy conservation performance standards for buildings is considered. It is shown that the appropriate price for energy is its social value, which can be determined through the development and application of resource impact factors (RIF's). Some guidelines are provided for the formulation and development of RIF's. A life-cycle cost minimization model for determining the optimum conservation standard is employed to show how the use of RIF's would generally lower the maximum allowable energy consumption specified in the standard. Finally, geometric and algebraic measures are derived for the net gain in economic efficiency that would result from using RIF's in developing energy conservation performance standards.

GRA

**N79-16385# Office of the County Clerk, El Centro, Calif.  
GEOTHERMAL ELEMENT, IMPERIAL COUNTY, CALIFORNIA.**

S. Edmunds, J. Sullivan, and M. Goldsmith 1977 156 p (Grant NSF AER-75-08793) (PB-287115/0; NSF/RA-770652) Avail: NTIS HC A08/MF A01 CSCL 10A

Research methodology a brief history of geothermal development in the county, and a general history and physical characteristics of the county are described. A framework of the county master plan for geothermal development, its implications, and short and long range planning procedures was also considered.

GRA

N79-16388

**N79-16388 Rutgers - The State Univ., New Brunswick, N. J.  
STIMULATED BIODEGRADATION OF WASTE PETROLEUM**

**Ph.D. Thesis**

John Thomas Dibble 1978 160 p

Avail: Univ. Microfilms Order No. 7901249

Petroleum spilled on land or water not contained and collected will eventually be subject to biodegradation. The disposal of refinery oil sludge by biodegradation in the soil is presently a partially defined process. This thesis is concerned with the development of methods to stimulate the rate and extent of petroleum biodegradation. The biodegradation of South Louisiana (SL) crude oil, and the effects of nitrogen, phosphorus and iron supplements on this process were compared in a polluted and in a relatively clean littoral seawater sample taken along the New Jersey coast. The optimal soil management practices for the disposal of waste oil sludges on land were determined in laboratory and field experiments. Various fertilizer formulations were tested in lysimeter columns for their effect on oil sludge biodegradation and leachate quality. An accidental pipeline break provided an opportunity to observe the effect of some of the developed management techniques in the large-scale rehabilitation of agricultural land.

Dissert. Abstr.

GRA

**N79-16389 Houston Univ., Tex.**

**ENVIRONMENTAL EFFECTS OF OFFSHORE OIL PRODUCTION Ph.D. Thesis**

Brenda Pitts Basile 1978 289 p

Avail: Univ. Microfilms Order No. 7901184

Analytical methodology for the quantitation of alkanes, aromatic hydrocarbons, and sulfur was developed and was applied to the study of the environmental effects of offshore oil production. Completely deuterated alkanes are separated from the corresponding unlabelled alkanes and serve as internal standards for the quantitation of environmental alkanes by gas chromatography alone. This technique provided a detection limit of .50 ng/l for hydrocarbons in seawater and 100 ng/g for hydrocarbons in sediments and in biological samples. The major conclusions from this study are: (1) There is petroleum contamination of water in this area of the Gulf of Mexico, but beyond 0.2 km of the production platform, this contamination cannot be ascribed to Buccaneer oilfield production activities. (2) Biota and sediments outside of the immediate vicinity of the production platforms do not contain petroleum hydrocarbons. This is especially important since this could affect the commercial fishing industry in the area.

Dissert. Abstr.

GRA

**N79-16437# California Univ., Santa Barbara. Marine Science Inst.**

**OIL POLLUTION REPORTS, VOLUME 6, NUMBER 2 Quarterly Report, Feb. - May 1978**

Helmut Ehrenspeck, Elizabeth Sorenson, Jim Cook, and Barbara Seales Aug. 1978 256 p refs

(Grant EPA-R-805052)

(PB-287071/5; EPA-600/7-78-160-Vol-5) Avail: NTIS HC A12/MF A01 CSCL 13B

A quarterly compilation of abstracts of current oil pollution-related literature, research projects, and conferences is presented. Comprehensive coverage of terrestrial and aquatic oil pollution and its prevention and control is provided, with emphasis on the marine environment. Citations and summaries of 1975 to 1978 scientific and technical publications, and patents; status and summaries of current research programs; and information on current meetings are given.

GRA

GRA

**N79-16439# Research Triangle Inst., Research Triangle Park, N. C.**

**COMPILATION OF LEVEL 1 ENVIRONMENTAL ASSESSMENT DATA Final Report, Sep. 1977 - Jun. 1978**

N. H. Gaskins and F. W. Sexton Oct. 1978 504 p refs

(Contract EPA-68-02-2156)

(PB-286924/6; EPA-600/2-78-211) Avail: NTIS HC A22/MF A01 CSCL 13B

The data are organized within each study by the analytical technique used to generate them. Each study is summarized,

followed by the data generated in that study. The studies are organized by industrial type: chemically active fluidized bed combustor, coal-fired boiler, coal-fired power plant, new energy source, coke production, electric arc furnace, fluidized bed combustor, home heater multi-source source, ocean incinerator, oil burner, and textile. The report documents sampling and analytical techniques that were used which are not specified in Level 1. It also includes trends and anomalies that were detected in the 19 studies.

GRA

**N79-16446# Catalytic, Inc., Charlotte, N. C.**

**ENVIRONMENTAL ASSESSMENT FOR RESIDUAL OIL UTILIZATION Annual Report, May 1977 - May 1978**

M. F. Tyndall, F. D. Kodras, J. K. Puckett, R. A. Symonds, and W. C. Yu Sep. 1978 183 p refs

(Contract EPA-68-02-2155)

(PB-286982/4; EPA-600/7-78-175; AR-2) Avail: NTIS HC A09/MF A01 CSCL 13B

Progress in an environmental assessment of processes using residual oil for electric power generation is reported. Emissions data from the literature and preliminary sampling are presented with material balances and flow diagrams for hydrodesulfurization, flue gas desulfurization, partial oxidation, and chemically active fluid bed processes. A computer program for a theoretical engineering analysis that will provide emissions output for the processes studied is described. Multimedia Environmental Goals (MEGs) and Minimum Acute Toxicity Effluents (MATEs) are used to develop pollutant prioritization and source analysis models. Methods for developing economic cost models are described.

GRA

**N79-16497# AIA Research Corp., Washington, D. C.**

**PHASE ONE/BASE DATA FOR THE DEVELOPMENT OF ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS. CLIMATIC CLASSIFICATION**

30 Jan. 1978 39 p

(Contract HUD-H-2689)

(PB-286900/6; HUD-0000190) Avail: NTIS HC A04/MF A01 CSCL 04B

Alternatives for the development of an adequate climatic classification system for use in establishing energy performance standards for new buildings were examined. Criteria were devised to ensure reasonable applicability of the selected climatic classification system, and a preliminary examination of climatic variables and their relationship to energy consumption was conducted. The development of a graphic matrix to illustrate relationships between estimated energy performance and both building type and climatic region is described and illustrated.

GRA

**N79-16668 Florida Univ., Gainesville.**

**MHD GENERATOR DUCT FLOW WITH CROSS STREAM DEPENDENT FLUID PROPERTIES Ph.D. Thesis**

Thomas Albert Trovillion 1978 207 p

Avail: Univ. Microfilms Order No. 7900099

The problem of steady laminar flow of an incompressible viscous conducting fluid in a rectangular duct is considered with finite aspect ratio of the cross section. An external magnetic field is applied transverse to the flow in a Faraday generator configuration. The governing equations for the modeling of the working fluid are derived from the usual magnetohydrodynamic assumptions yielding two simultaneous equations in terms of the velocity and induced magnetic field. A finite difference approach is taken to the solution of these equations using a modification of the Peaceman Rachford alternating direction implicit relaxation scheme. The finite difference solution is employed to obtain plots of the current streamlines and velocity contours, the volume flow rate through the channel, and the efficiency of the generator. These results are then examined to determine the effect on the flow characteristics produced by changes in load resistance, electrode conductivity, aspect ratio, and the assumed profile of conductivity and viscosity variation.

Dissert. Abstr.

GRA

**N79-16704 Oklahoma Univ., Norman.**

**THERMAL AND KINETIC ANALYSIS OF THE PYROLYSIS OF COALS Ph.D. Thesis**

Vidyutkumar Varmanray Hathi 1978 275 p

Avail: Univ. Microfilms Order No. 7824598

The thermal decomposition (pyrolysis) of nine bituminous coals of the United States was investigated in a nitrogen atmosphere. Weight loss and rate of weight loss were measured at heating rates of 160, 80, 40, 20 and 10 C/min. The qualitative behavior of these data confirmed observations reported by others on similar coals in that the major devolatilization occurred between 300-700 C with the peaks shifting to higher temperatures at faster heating rates. Kinetic parameters for each heating rate were derived from these measurements by means of a model, which was used successfully to describe the pyrolysis of woods and wildland fuels. The decomposition of bituminous coals is endothermic up to 500 C and exothermic thereafter; the energy of pyrolysis is more exothermic with decreasing heating rates.

Dissert. Abstr.

**N79-16721\***# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**INITIAL COMPARISON OF SINGLE CYLINDER STIRLING ENGINE COMPUTER MODEL PREDICTIONS WITH TEST RESULTS**

Roy C. Tew, Jr., Lanny G. Thieme, and David Miao 1979 37 p refs Presented at the Intern. Congr. and Exposition, Detroit, 26 Feb. 1979 - 4 Mar. 1979; sponsored by the Soc. of Automotive Engr.

(Contract EC-77-A-31-1040)

(NASA-TM-79044; DOE/NASA/1040-78/30; E-9848) Avail: NTIS HC A03/MF A01 CSCL 10B

A Stirling engine digital computer model developed at NASA Lewis Research Center was configured to predict the performance of the GPU-3 single-cylinder rhombic drive engine. Revisions to the basic equations and assumptions are discussed. Model predictions with the early results of the Lewis Research Center GPU-3 tests are compared. A.R.H.

**N79-16848\***# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

**THE AGARD PROPULSION AND ENERGETICS PANEL, 1962-1977**

S. S. Penner (California Univ. at San Diego, La Jolla) Jan. 1978 34 p refs

(AGARD-AR-111; ISBN-92-835-1258-8) Avail: NTIS HC A03/MF A01

Work done during the past 25 years by the AGARD Propulsion and Energetics Panel formerly named Combustion and Propulsion Panel, and initially, Combustion Panel is summarized. The adaptation of the Panel to challenging demands of propulsion technology and the impact of Panel activities on research and development within NATO countries are analyzed. A move in future Panel activities, particularly long term emphasis of energy related topics is suggested. Proposals on publication and publicity policies are included. A.R.H.

**N79-16850\***# Pratt and Whitney Aircraft, East Hartford, Conn. ENERGY EFFICIENT ENGINE: PROPULSION SYSTEM-AIRCRAFT INTEGRATION EVALUATION Topical Report, Mar. 1978 - Sep. 1978

R. E. Owens Mar. 1979 311 p refs

(Contract NAS3-20646)

(NASA-CR-159488; PWA-5594-48) Avail: NTIS HC A14/MF A01 CSCL 21E

Flight performance and operating economics of future commercial transports utilizing the energy efficient engine were assessed as well as the probability of meeting NASA's goals for TSFC, DOC, noise, and emissions. Results of the initial propulsion systems aircraft integration evaluation presented include estimates of engine performance, predictions of fuel burns, operating costs of the flight propulsion system installed in seven selected advanced study commercial transports, estimates of noise and emissions, considerations of thrust growth, and the achievement-probability analysis. A.R.H.

**N79-16874#** Lockheed-California Co., Burbank. Structural and Material Div.

**FUEL CONSERVATIVE SUBSONIC TRANSPORT**

W. A. Stauffer, R. L. Foss, and J. G. Lewolt In AGARD Active Controls in Aircraft Design Nov. 1978 13 p refs

Avail: NTIS HC A09/MF A01

A fuel saving active control system being developed for commercial application of the L-1011 airplane in the early 1980s is described. Highlighted are features of the TriStar that permit an effective yet simple load relieving system to be adopted. A description of the active control system, which involves integrated movement of both the aileron and horizontal tail, is given. The load relieving benefits obtained and the ability to increase wing span without major structural change are discussed. The potential fuel savings offered by this system is indicated. Comments on the structural design criteria established for the system, the analytic models employed in the active controls analysis, and the initial breadboard control system hardware defined for ground and flight test purposes are included. Also described are ground simulation and flight test plans and results, and thoughts on further application of active controls for future consideration. J.M.S.

**N79-16892#** Axiomatix, Marina del Rey, Calif.

**MICROWAVE SYSTEMS ANALYSIS, SOLAR POWER SATELLITE Final Report**

8 Jan. 1979 110 p

(Contract NAS9-15240)

(NASA-CR-160091; R7901-1) Avail: NTIS HC A06/MF A01 CSCL 22B

Various alternative active approaches to achieving and maintaining flatness for the microwave power transmission system (MPTS) were studied. A baseline active alignment scheme was developed which includes subarray attachment mechanisms, height and tilting adjustments, service corridors, a rotating laser beam reference system, monopulse pointing techniques, and the design of a beam-centering photoconductive sensor. J.M.S.

**N79-16893#** Department of Energy, Washington, D. C.

**SATELLITE POWER SYSTEM (SPS) PROGRAM SUMMARY**

Dec. 1978 116 p refs

(DOE/ER-0022) Avail: NTIS HC A06/MF A01

In April 1978, a Satellite Power System (SPS) Project office was established in the Office of Energy Research to manage all activities in this program area. The director of the project office focuses on SPS findings, prepares reports and provides recommendations to DOE management with regard to major and national decisions regarding future SPS development. Outlined in this annual Program Summary are: (1) fiscal year 1978 and 1979 summary tables; (2) systems definition studies; (3) environmental assessment studies; (4) societal assessment studies; and (5) comparative assessment studies. G.Y.

**N79-16895#** Ozeroff (Michael J.), Pacific Palisades, Calif.

**SATELLITE POWER SYSTEM (SPS) MILITARY APPLICATIONS**

Michael J. Ozeroff Oct. 1978 45 p refs Sponsored by NASA Prepared for PRC Energy Analysis Co., McLean, Va.

(Contract EG-77-C-01-4024)

(NASA-CR-158109; HCP/R-4024-01) Avail: NTIS HC A03/MF A01 CSCL 22A

The potential military role, both offensive and defensive, of a Satellite Power System (SPS) is examined. A number of potential military support possibilities are described. An SPS with military capabilities may have a strong negative impact on international relations if it is not internationalized. The SPS satellite would be vulnerable to military action of an enemy with good space capability, but would experience little or no threat from saboteurs or terrorists, except via the ground controls. The paper concludes with an outline of some of the key issues involved, and a number of recommendations for future study, including some areas for long term efforts. G.Y.

N79-16930

**N79-16930\***# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

**EVALUATION OF THE APPLICATION OF SOME GAS CHROMATOGRAPHIC METHODS FOR THE DETERMINATION OF PROPERTIES OF SYNTHETIC FUELS**

Albert C. Antoine Jan. 1979 46 p refs Presented at the Aerospace Meeting, San Diego, Calif., 27-30 Nov., 1978; sponsored by the Soc. of Automotive Engr. (NASA-TM-79035; E-9834) Avail: NTIS HC A03/MF A01 CSCL 21B

The purpose of the investigation was to evaluate the applicability, to some synthetic fuels, of some gas chromatographic methods now under development for use with petroleum based fuels. Thirty-two jet and diesel fuel samples which were prepared from oil shale and coal syncrudes were examined. The boiling range distribution of each was determined by gas chromatography, and from that data distillation properties were calculated. The calculated results gave sufficient agreement with the measured values that the equations could be useable in their present form. Bulk fuel properties were calculated for the sixteen JP-5 and Diesel No. 2 type fuels. The results show that the equations would not give useable results. Capillary column gas chromatography was used to determine the n-alkane content of the eight JP-5 type samples and the results related to the observed freezing points. The results show that the concentrations of the long straight chain molecules in the fuels exert influence on the freezing point but are not the complete controlling factor. L.S.

**N79-16997\***# National Aeronautics and Space Administration, Washington, D. C.

**HYDROGEN TECHNOLOGY FROM THERMONUCLEAR RESEARCH**

In its Liquid Hydrogen as a Propulsion Fuel, 1945-1959 1978 p 63-71

Avail: NTIS MF A01: HC SOD CSCL 21D

Under the stimulus of hydrogen bomb development, liquid hydrogen technology advanced rapidly in the first part of the 1950s. A historical review of the scientists and their efforts in advancing this technology from thermonuclear research is presented. The development of the National Cryogenic Engineering Laboratory and mobile liquid hydrogen equipment during this period is discussed. Cryogenic information exchange conferences sponsored by the National Cryogenic Engineering Laboratory are also discussed. G.Y.

**N79-16999\***# National Aeronautics and Space Administration, Washington, D. C.

**NACA RESEARCH ON HYDROGEN FOR HIGH ALTITUDE AIRCRAFT**

In its Liquid Hydrogen as a Propulsion Fuel, 1945-1959 1978 p 95-112

Avail: NTIS MF A01: HC SOD CSCL 21D

In 1954, the fuels and propulsion panel of the Scientific Advisory Board met to survey the major aspects of the propulsion program of the Air Force. The panel was greatly interested in high-energy fuels and the Air Force program on them. A proposal was introduced to use hydrogen in a high altitude aircraft powered by a unique engine called Rex 1. This touched off a strong renewal of interest in liquid hydrogen for aircraft. The historical investigations, during 1954-1957, of liquid hydrogen for high altitude aircraft and missiles are discussed. The experiments began with an investigation of low pressure combustion in a single turbojet combustor, extended to other components and complete turbojet engine systems, and culminated in the first (and only) flight experiments. A partial list of the many contributions of this research effort is presented. G.Y.

**N79-17000\***# National Aeronautics and Space Administration, Washington, D. C.

**NEW INITIATIVES IN HIGH ALTITUDE AIRCRAFT**

In its Liquid Hydrogen as a Propulsion Fuel, 1945-1959 1978 p 112-139 refs

Avail: NTIS MF A01: HC SOD CSCL 21D

The Air Force began planning work to achieve very-high altitude flight in late 1952. In 1954, a high-altitude reconnaissance

airplane that was sponsored by the government was proposed. This became the U-2 aircraft. In 1954, a novel hydrogen fueled subsonic airplane capable of high-altitude flight was proposed. Although never built, it spawned considerable interest and activity on the potential of hydrogen as a fuel. An account of the contract work undertaken to develop the airplane and its engine is presented. As interest grew and specifications changed from a subsonic to a supersonic airplane the required engine power increased. This meant a much larger hydrogen fueled engine. The growth in engine size effectively took the contractor out of competition. This case history of an inventor and contractor and their frustrations with a single customer (U.S. Government) is analyzed.

G.Y.

**N79-17011\***# Purdue Univ., Lafayette, Ind. School of Mechanical Engineering.

**ALTERNATIVE HYDROCARBON FUELS: COMBUSTION AND CHEMICAL KINETICS**

Craig T. Bowman, ed. (Stanford Univ., Calif.) and Jorgen Birkeland, ed. (DOE, Washington, D. C.) Oct. 1978 473 p refs Proc. of a Proj. SQUID Workshop held at Loyola Coll. Conf. Center, Columbia, Md., 7-9 Sep. 1977 Sponsored in part by AFOSR and DOE

(Contract N00014-75-C-1143; Proj. SQUID; NR Proj. 098-038) (AD-A061050; SQUID-PU-R2-78) Avail: NTIS HC A20/MF A01 CSCL 21/4

Contents: Alternative Fuel Availability and Anticipated Combustion Problems; Critical Processes in Combustion of Alternative Fuels; Pyrolysis and Oxidation Kinetics of Alternative Fuels; Pollutant Emissions Considerations for Alternative Fuel Combustion; and Summary and Conclusions. GRA

**N79-17019\***# Transportation Systems Center, Cambridge, Mass. **PROCEEDINGS OF SYMPOSIUM ON WATER-IN-FUEL EMULSIONS IN COMBUSTION Final Report**

Robert Walter, ed. and James White, ed. (Coast Guard, Washington, D.C.) Sep. 1978 220 p refs Symp. held at Cambridge, Mass., 20-21 Apr. 1977 (AD-A061503; TSC-USCG-78-12; USCG-D-12-78) Avail: NTIS HC A10/MF A01 CSCL 21/4

This volume contains the proceedings of a symposium on water-in-fuel emulsions held at the DOT Transportation Systems Center April 20 and 21, 1977. This symposium, sponsored by the DOT's U.S. Coast Guard and Office of the Secretary, provided a forum for researchers involved in the use of water-in-fuel emulsions in combustion. Participants from academia, industry and government contributed papers and discussed the properties, production and utilization of water-in-fuel emulsions in boilers, diesels, and gas turbines. These proceedings contain the abstracts of 18 papers as well as the discussions on these papers and recommendations for needed research in emulsified fuel technology. Also included are a list of attendees and a bibliography on the subject of emulsified fuels. Author (GRA)

**N79-17025\***# Battelle Memorial Inst., Columbus, Ohio. Columbus Labs.

**COMBUSTION OF HYDROTHERMALLY TREATED COALS Final Report, Aug. 1975 - Jun. 1977**

E. P. Stambaugh, R. D. Giannar, and K. C. Sekhar Apr. 1978 156 p refs (Contract EPA-68-02-2119) (PB-287521/9; EPA-600/7-78-068) Avail: NTIS HC A08/MF A01 CSCL 21D

The report gives results of an evaluation of: (1) the relationship of the combustion characteristics of hydrothermally treated (HTT) coals to environmental emissions, boiler design, and interchangeability of solid fuels produced by the Hydrothermal Coal Process (HCP) with raw coals currently being used as the source of energy; and (2) the conversion of solubilized coal to terephthalic acid. Results indicate that the HTT coals are clean solid fuels that, in many instances, can be burned with little or no sulfur emissions. Flue gas SO<sub>2</sub> concentrations were well below Federal Sulfur Emission Standards for New Sources. The HTT coal was found to burn as well as or better than raw coal.

Trace metals emissions should be significantly reduced because of the lower concentrations in HTT coals. HTT coals appear to be more suitable for firing in wet-bottom than in dry bottom furnaces because of potential fouling and slagging associated with their alkali content. However, additives may possibly be used to reduce fouling and slagging. GRA

**N79-17026#** Hydrocarbon Research, Inc., Lawrenceville, N. J.  
**CATALYST EVALUATION FOR DENITROGENATION OF PETROLEUM RESIDUA AND COAL LIQUIDS, PHASE 6 Progress Report, Sep. 1975 - Feb. 1978**  
 Cecelia C. Kang and Jeffrey Gendler Aug. 1978 57 p  
 (Contract EPA-68-02-0293)  
 (PB-287180/4: EPA-600/7-78-159) Avail: NTIS HC A04/MF A01 CSCL 21D

The catalysts for demetalization of heavy residual oils and for denitrogenation were studied. Some commercial catalysts for denitrogenation activity in petroleum residua and coal liquids were evaluated and an improved catalyst for denitrogenation of heavy coal liquids was developed. Under one task, two commercial catalysts failed to reduce nitrogen content of a petroleum vacuum residual from 0.67% to the 0.3% target. The observed catalyst deactivation rate is similar to that of catalysts with similar pore structures which are being used for hydrodesulfurization of petroleum residual. Under another task, attempts to denitrogenate heavy coal-derived liquids with commercial Co-Mo catalysts pointed to the need for improved catalysts. In the task to improve catalysts, Ni-Mo was identified as a better active metal pair than Co-Mo or Ni-W for denitrogenation of coal liquids. GRA

**N79-17027#** Research Triangle Inst., Research Triangle Park, N. C.  
**POLLUTANTS FROM SYNTHETIC FUELS PRODUCTION: FACILITY CONSTRUCTION AND PRELIMINARY TESTS Phase Report, Nov. 1978 - Apr. 1978**  
 J. G. Cleland, F. O. Mixon, D. G. Nichols, C. M. Sparacino, and D. E. Wagoner Aug. 1978 128 p refs  
 (Grant EPA-R-804979)  
 (PB-287730/6: EPA-600/7-78-171) Avail: NTIS HC A07/MF A01 CSCL 07D

The factors and conditions that cause the production of environmental pollutants in synthetic fuel processes were investigated. Tasks described include: operation of a laboratory-scale coal gasification facility; collection and chemical analysis of effluent stream samples; compilation and analysis of resulting data; and evaluation of these data. The experimental system operates successfully and reliably at gasification temperatures up to 1370 K, pressures up to 1.2 MPa, and gas generation rates of about 20 standard liters/min. The major pollutant classes are benzene and its substituents, thiols and sulfides, phenols, fused polycyclics, sulfur heterocyclics, and inorganic sulfur compounds. GRA

**N79-17118#** Defence Research Establishment, Ottawa, (Ontario).  
**POWER SUPPLIES FOR ARCTIC RADIO REPEATER SYSTEMS**  
 Gerald D. Nagy Sep. 1978 50 p refs  
 (AD-A061609; DREO-R-787) Avail: NTIS HC A03/MF A01 CSCL 17/2

This feasibility study assesses various long lived, self-contained 30 watt power supplies for an Arctic Radio Repeater System. The study involves a review of the state-of-the-art, availability and cost of five candidate systems: batteries, fuel cells; radioisotopic thermoelectric generators, fueled thermoelectric generators and windmill-battery systems. The above five candidates were also assessed as standby power units. Reliability, service and maintenance requirements are considered since the application calls for one year unattended operation and servicing by light helicopter on a single annual flight for all sites. Only zinc/air batteries with lead/acid batteries for the standby system are available now. Their cost is moderate, but zinc/air cells are heavy and must be replaced each year. Other systems could be available in the 1980's but they would require various amounts of development work and evaluation in an arctic environment.

Recommendations and priorities for development of the systems which could replace the zinc/air cells at a later date are given. Author (GRA)

**N79-17230#** Aeronautical Research Labs., Melbourne (Australia).  
**TESTS OF WISCONSIN S12D ENGINE RUNNING ON NATURAL GAS WITH ADDITION OF CARBON DIOXIDE**  
 B. G. Catchpole and T. S. Keeble May 1978 14 p refs  
 (AD-A058486; ARL/MECH-ENG-TM-391) Avail: NTIS HC A02/MF A01 CSCL 21/7

Natural gas or bio-gas are possible alternative fuels to petrol in Otto-cycle engines. A commercial, single-cylinder, spark-ignition engine has been run on various mixtures of natural gas with carbon dioxide to gain experience of its operation and compare its behaviour with operation using petrol. While there was a considerable drop in power with straight natural gas, the specific fuel consumption was not greatly affected. No attempt was made to advance the spark timing or to increase the compression ratio although both of these changes would be expected to improve the performance considerably. When operating on gas, it was found possible to vary the power of the engine over a wide range by varying the mixture strength, as in a diesel. Performance was little affected by increase of carbon dioxide content up to 47%. Author (GRA)

**N79-17289\*** Tennessee Univ. Space Inst., Tullahoma. Remote Sensing Div.

**APPLYING NASA REMOTE SENSING DATA TO GEOLOGICALLY RELATED REGIONAL PLANNING PROBLEMS IN TENNESSEE Final Report**

1978 70 p Workshop held at Tullahoma, Tenn., 10-11 Mar. 1978 ERTS  
 (Contract NAS8-32034)  
 (E79-10095: NASA-CR-150866) Avail: NTIS HC A04/MF A01 CSCL 08G

There are no author-identified significant results in this report.

**N79-17291#** Zentralstelle fuer Geo-Photogrammetrie und Fernerkundung, Munich (West Germany).

**APPLICATION OF LANDSAT DATA AND DIGITAL IMAGE PROCESSING Technical Report, 1975 - 1978**

J. Bodechtel, Principal Investigator May 1978 169 p refs Sponsored by NASA Original contains color imagery. Original photography may be purchased from the EROS Data Center, Sioux Falls, S. D. 57198 ERTS  
 (E79-10102: NASA-CR-158058) Avail: NTIS HC A08/MF A01 CSCL 05B

The author has identified the following significant results. Based on LANDSAT 1 and 2 data, applications in the fields of coal mining, lignite exploration, and thematic mapping in geology are demonstrated. The hybrid image processing system, its software, and its utilization for educational purposes is described. A pre-operational European satellite is proposed.

**N79-17309#** Fish and Wildlife Service, Fort Collins, Colo. Western Energy and Land Use Team.

**RESERVOIR ECOSYSTEMS AND WESTERN COAL DEVELOPMENT IN THE UPPER MISSOURI RIVER BASIN Summary Report**

William Nelson Jul. 1978 16 p  
 (PB-287363/6: FWS/OBS-78/25) Avail: NTIS HC A02/MF A01 CSCL 13B

An ecological overview evaluating the limnology, water chemistry and fisheries of lakes Fort Peck and Sakakawea is presented. Specifically, the survey provides an overview of baseline conditions, describes various developments and their impacts, identifies mitigation measures, and delineates further research needs. Additionally, the data collected over the study year from the two upper impoundments, Lake Peck and Lake Sakakawea, is compared with the more comprehensive data compiled over a period of several years on the lower four reservoirs to determine the extent of the physical, chemical and biological similarity among the respective systems. GRA

N79-17311

**N79-17311# NALCO Environmental Sciences, Northbrook, Ill.  
ATLAS OF WESTERN SURFACE-MINED LANDS: COAL,  
URANIUM, AND PHOSPHATE**

A. Kent Evans, E. W. Uhleman, and P. A. Eby Jan. 1978  
396 p refs

(Contracts DI-14-13-0009-77-004; EPA-IAG-D6-E695)  
(PB-287846/0; FWS/OBS-78/20; LC-78-600096) Avail:  
NTIS HC A17/MF A01 CSCL 081

The atlas contains available information on all coal, uranium, and phosphate surface mines in excess of 10 acres that were in operation prior to 1976 in the western 11 contiguous states plus North Dakota and South Dakota. It is assembled in a format that allows a systematic and comprehensive review of surface-mined lands so that appropriate areas can be selected for intensive biological assessment of natural and man-induced revegetation and refaunaization.

GRA

**N79-17316# Council for Scientific and Industrial Research,  
Pretoria (South Africa).**

**SYMPORIUM ON ENERGY TODAY AND TOMORROW**  
1977 185 p refs Symp. held at Pretoria, October 1977  
(CSIR-S-145) Avail: NTIS HC A09/MF A01

The demand and supply of energy sources in the near future are discussed. Coal processing plant designs are reviewed for South Africa and Australia. The development of alternate energy sources, such as solar and nuclear, is also considered.

**N79-17317# Atomic Energy Board, Pretoria (South Africa).  
NUCLEAR POWER TODAY AND TOMORROW**

K. T. Brown In CSIR Symp. on Energy Today and Tomorrow  
1977 11 p ref

Avail: NTIS HC A09/MF A01

A realistic assessment of the contribution which nuclear power is making now, and can make in the future, towards satisfying global energy demands is presented. Global reserves of nuclear fuel are relatively small in terms of utilization by current commercial technology. In the long term the intrinsic value of nuclear fuel reserves may be multiplied many times by technological developments, but a number of factors will be of influence in realizing such enhancement. Social, political and economic parameters have slowed the projected growth of nuclear power in recent years. The aftermath of the oil dislocation and price rises is not yet over, and future tendencies remain difficult to predict in the prevailing general atmosphere of unwarranted complacency regarding energy supplies.

J.A.M.

**N79-17318# Council for Scientific and Industrial Research,  
Pretoria (South Africa).**

**COAL PREPARATION DESIGN FOR EXPORT MARKETS,  
WITH PARTICULAR REFERENCE TO SOUTH AFRICAN AND  
CANADIAN COALS**

S. G. Butcher (Sirion-Carves of Canada Limited) In its Symp. on Energy Today and Tomorrow 1977 22 p refs

Avail: NTIS HC A09/MF A01

South African and Canadian coals are described, including their washability characteristics and extremely fine size. Plant design factors, test work validity, process optimization, and plant flexibility are reviewed. Environmental and contractual limitations are also cited.

J.A.M.

**N79-17319# Council for Scientific and Industrial Research,  
Pretoria (South Africa).**

**INFLUENCE OF MARKETING REQUIREMENTS ON DEFINITION  
OF COAL RESOURCES**

F. Pollard (Australian Coal Industry Research Labs. Ltd.) In its Symp. on Energy Today and Tomorrow 1977 12 p

Avail: NTIS HC A09/MF A01

A method of examination of borecores was developed which was especially designed to provide data that can be used for the evaluation of the preparation requirements of the output of a future mine. Samples can also be prepared from the borecores which simulate the future marketable product to a close degree

particularly with regard to screen analysis and to vitrinite and mineral matter distribution throughout the particle size range. The use of this technique for examination of borecores has reduced the time required to assess a coal deposit and provides data from the laboratory oriented to the practical situation which will exist when the mine is opened. Decisions on mine planning, marketable coal quality, utilization and the necessary preparation systems in some areas of Australia were based entirely upon the laboratory evaluation of borecore samples.

J.A.M.

**N79-17320# American Gas Association, Inc., Arlington, Va.  
DIRECTION OF GAS SUPPLY RESEARCH IN THE US**  
Ab Flowers In CSIR Symp. on Energy Today and Tomorrow  
1977 11 p

Avail: NTIS HC A09/MF A01

Research was accelerated to increase supplies from supplemental sources, such as, enhanced recovery of tight formations, gas from coal seams, and coal gasification. Research is also underway to develop supplies of gaseous fuels for the long term. Development of second generation coal technology (hydrogen from water and methane from marine biomass) is discussed.

J.A.M.

**N79-17321# Council for Scientific and Industrial Research,  
Pretoria (South Africa).**

**COAL GASIFICATION AND SOUTH AFRICA**

D. Clark (Fuel Research Inst. of South Africa) In its Symp. on Energy Today and Tomorrow 1977 29 p refs

Avail: NTIS HC A09/MF A01

Lacking the cheap indigenous hydrocarbon resources of the Western World, South Africa has continued to generate fuel and process gases from its relatively cheap coal. This has helped towards a measure of strategic and economic self sufficiency. The current status of the technology, some of its problems, and its future potential are reviewed.

J.A.M.

**N79-17322# Council for Scientific and Industrial Research,  
Pretoria (South Africa).**

**ENERGY REQUIREMENTS FOR PRODUCING STEEL IN THE  
REPUBLIC OF SOUTH AFRICA**

W. J. Sander (Fuel Research Inst. of South Africa, Pretoria) In its Symp. on Energy Today and Tomorrow 1977 21 p refs

Avail: NTIS HC A09/MF A01

Available information on the energy requirements for producing steel is reviewed. The blast furnace route, using conventional coke as a fuel, is discussed. Two different alternative routes are subsequently examined namely: (1) the use of formcoke instead of conventional coke in the blast furnace, and (2) the elimination of the blast furnace by applying direct reduction processes. The energy requirements for the application of the different routes are compared.

J.A.M.

**N79-17323# Council for Scientific and Industrial Research,  
Pretoria (South Africa).**

**DESCRIPTION OF HYDRO-ELECTRIC DEVELOPMENT AND  
PROPOSAL FOR FUTURE DEVELOPMENT ON THE  
ZAMBEZI**

E. M. Shepherd (Central African Power Corp.) In its Symp. on Energy Today and Tomorrow 1977 15 p

Avail: NTIS HC A09/MF A01

The Zambezi River and its hydro-electric potential are examined with particular reference to the stretch of river forming the boundary between Rhodesia and Zambia on which there is a potential of some 5,500MW and 35,000 million kWh per annum. The present state of development and of possible future development are described.

J.A.M.

**N79-17324# Council for Scientific and Industrial Research,  
Pretoria (South Africa).**

**LOW-TEMPERATURE APPLICATION OF SOLAR ENERGY  
IN SOUTH AFRICA**

W. N. Cawood and M. Johnson *In its Symp. on Energy Today and Tomorrow* 1977 32 p refs

Avail: NTIS HC A09/MF A01

The suitability of solar energy is demonstrated in the area of low temperature applications, such as water and space heating, and low temperature process heating for industry and agriculture. How much energy from conventional sources could be saved in the domestic sector is also indicated. J.A.M.

**N79-17325#** Council for Scientific and Industrial Research, Pretoria (South Africa).

**THE PLANNING AND ECONOMIC ASPECTS OF ENERGY SUPPLY AND DEMAND IN SOUTH AFRICA**

D. J. Kotze (Department of Planning and the Environment) *In its Symp. on Energy Today and Tomorrow* 1977 12 p

Avail: NTIS HC A09/MF A01

The energy problem is essentially international in character and a brief diagnosis of the world energy situation is made. From this, it appears that a growing imbalance between world energy supply and demand is developing which must inevitably lead to, what is called, the real energy crisis. No country, not even South Africa, can isolate itself from these events. Elements in this conflict situation are analyzed, and recommendations are made. Author

**N79-17326#** Council for Scientific and Industrial Research, Pretoria (South Africa).

**ENERGY TODAY AND TOMORROW**

I. Fells *In its Symp. on Energy Today and Tomorrow* 1977 11 p

Avail: NTIS HC A09/MF A01

World wide, there is a glut of energy which has inhibited the implementation of energy conservation programs. If world energy demand growth continues at 5 per cent per annum, the position will quickly change and serious shortages of oil and gas will arise in the mid 1980's. Deficiencies in energy supply cannot be made up by nuclear power or coal as expansion programs are already slipping badly. This may have been rectified by 2000 but a massive investment in nuclear, coal, and alternative energy resources will be necessary if only a modest growth in energy demand is to be maintained. The high growth of the last 20 years cannot be sustained into the next century. Author

**N79-17328#** Wyle Labs., Inc., Huntsville, Ala. Solar Energy Systems Div.

**LONG TERM WEATHERING EFFECTS ON THE THERMAL PERFORMANCE OF THE SUNWORKS (LIQUID) SOLAR COLLECTOR**

Jan. 1979 11 p refs Prepared for DOE  
(Contract NASB-32036)  
(NASA-CR-150899) Avail: NTIS HC A02/MF A01 CSCL 10A

The test procedures used and the results obtained during the evaluation test program of the Sunworks single-covered liquid solar collector are presented. The tests were performed under simulated conditions, following long-term exposure to natural weathering conditions. The sunworks collector is a flat-plate solar collector. The absorber plate is copper with copper tubes bonded by soft solder, and is coated with Enthon selective black with an absorptivity factor of .87 similar to .92 and an emissivity factor of .10 similar to .20. It has a single glass cover of 3/16 inches tempered glass and weighs about 115 pounds. The overall dimensions of the collector are 36 x 84 x 4 inches. G.Y.

**N79-17329#** California Univ., Berkeley. Lawrence Berkeley Lab.

**ENERGY CONSERVATION: POLICY ISSUES AND END-USE SCENARIOS OF SAVINGS POTENTIAL PART 1: SUMMARY**

Sep. 1978 46 p 6 Vol.  
(Contract W-7405-eng-48)  
(LBL-7896) Avail: NTIS HC A03/MF A01

The following topics are discussed: (1) energy efficient buildings; (2) energy efficient recreational travel; (3) policy barriers and investment decisions in industry; (4) tradeoffs of municipal solid waste processing alternatives; and (5) end-use energy conservation data base and scenarios. G.Y.

**N79-17331# CALMAC Mfg. Co., Englewood, N. J. CERTIFICATION REPORT FOR THE CALMAC SOLAR POWERED PUMP**

Dec. 1978 40 p Prepared for DOE  
(Contract NASB-32253)  
(NASA-CR-150872) Avail: NTIS HC A03/MF A01 CSCL 10A

The certification of the CALMAC solar powered thermopump is presented. Each element of the specification is delineated, together with the verification, based on analysis, similarity, inspection, or testing. J.M.S.

**N79-17332# Owens-Illinois, Inc., Toledo, Ohio. PRELIMINARY DESIGN PACKAGE FOR SUNAIR SEC-601 SOLAR COLLECTOR**

Dec. 1978 60 p Prepared for DOE  
(Contract NASB-32259)  
(NASA-CR-150875) Avail: NTIS HC A04/MF A01 CSCL 10A

The preliminary design of the Owens-Illinois model Sunair SEC-601 tubular air solar-collector is presented. Information in this package includes the subsystem design and development approaches, hazard analysis, and detailed drawings available as the preliminary design review. G.Y.

**N79-17333# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.**

**A 200-KW WIND TURBINE GENERATOR CONCEPTUAL DESIGN STUDY**

Jan. 1979 111 p refs  
(Contract E(49-26)-1028)  
(NASA-TM-79032; DOE/NASA/1028-79/1) Avail: NTIS HC A06/MF A01 CSCL 10B

A conceptual design study was conducted to define a 200 kW wind turbine power system configuration for remote applications. The goal was to attain an energy cost of 1 to 2 cents per kilowatt-hour at a 14-mph site (mean average wind velocity at an altitude of 30 ft.) The costs of the Clayton, New Mexico, Mod-OA (200-kW) were used to identify the components, subsystems, and other factors that were high in cost and thus candidates for cost reduction. Efforts devoted to developing component and subsystem concepts and ideas resulted in a machine concept that is considerably simpler, lighter in weight, and lower in cost than the present Mod-OA wind turbines. In this report are described the various innovations that contributed to the lower cost and lighter weight design as well as the method used to calculate the cost of energy. Author

**N79-17335# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.**

**EVALUATION OF THE ECAS OPEN CYCLE MHD POWER PLANT DESIGN Final Report**

George R. Seikel, Peter J. Staiger, and Carlson C. P. Pian Nov. 1978 27 p refs Prepared for DOE  
(Contract EF-77-A-01-2674)  
(NASA-TM-79012, E-9799; DOE/NASA/2674-78/2) Avail: NTIS HC A03/MF A01 CSCL 10B

The Energy Conversion Alternatives Study (ECAS) MHD/steam power plant is described. The NASA critical evaluation of the design is summarized. Performance of the MHD plant is compared to that of the other type ECAS plant designs on the basis of efficiency and the 30-year levelized cost of electricity. Techniques to improve the plant design and the potential performance of lower technology plants requiring shorter development time and lower development cost are then discussed. Author

## N79-17336

**N79-17336#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

### **PHOTOVOLTAIC TESTS AND APPLICATIONS PROJECT Final Progress Report, Apr. 1978 - Jun. 1977**

Nov. 1978 90 p refs

(Contract E(49-26)-1022)

(NASA-TM-79018; E-9811; DOE/NASA/1022-78/42) Avail: NTIS HC A05/MF A01 CSCL 10A

The activities and accomplishments of the Photovoltaic Tests and Applications Project during the period April 1976 through June 1977 are summarized. Results of efforts to identify potential near-term photovoltaic applications and users are discussed, including the outcome of an extensive survey of Federal government agencies. The status of application experiments is presented. Various general engineering efforts are reported, including the design and construction of a photovoltaic Systems Test Facility. Efforts to develop a high efficiency 10 kVA self-commutated inverter and controller specifically designed for photovoltaic systems are also discussed. The results of a wide variety of activities in the area of photovoltaic measurements and standards are related. Documents generated by the Project during the reporting period are listed in an Appendix. G.Y.

**N79-17337#** California Univ., Livermore. Lawrence Livermore Lab.

### **COMPARATIVE COST ANALYSES: TOTAL FLOW VS OTHER POWER CONVERSION SYSTEMS FOR THE SALTON SEA GEOTHERMAL RESOURCE**

Gerald W. Wright 18 Sep. 1978 35 p refs

(Contract W-7405-eng-48)

(UCRL-52589) Avail: NTIS HC A03/MF A01

Cost studies were done for Total Flow, double flash, and multistage flash binary systems for electric energy production from the Salton Sea Geothermal Resource. The purpose was to provide the Department of Energy's Division of Geothermal Energy with information by which to judge whether to continue development of the Total Flow system. Results indicate that the Total Flow and double flash systems have capital costs of \$1,135 and \$1,026 /kW with energy costs of 40.9 and 39.7 mills/kW hr. respectively. The Total Flow and double flash systems are not distinguishable on a cost basis alone; the the multistage flash binary system, with capital cost of \$1,343 /kW and energy cost of 46.9 mills/kW hr., is significantly more expensive. If oil savings are considered in the total analysis, the Total Flow system could save 30% more oil than the double flash system--\$3.5 billion at 1978 oil prices. Author

**N79-17338#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

### **DEVELOPMENT, TESTING, AND CERTIFICATION OF CALMAC MFG. CORP. SOLAR COLLECTOR AND SOLAR OPERATED PUMP Final Report**

John C. Parker Jan. 1979 30 p refs Prepared for DOE (NASA-TM-78218) Avail: NTIS HC A03/MF A01 CSCL 10A

Development of a rubber tube solar collector and solar operated pump for use with solar heating and cooling systems is discussed. The development hardware, problems encountered during fabrication and testing, and certification statements of performance are included. J.M.S.

**N79-17339#** Committee on Science and Technology (U S. House).

### **RESEARCH AND DEVELOPMENT NEEDS TO MERGE ENVIRONMENTAL AND ENERGY OBJECTIVES**

Robert E. Trumbale, Joseph P. Biniek, John E. Blodgett, and Carl E. Behrens Washington GPO 1978 270 p refs Rept. for Subcomm. on the Environment and the Atmosphere of the Comm. on Sci. and Technol., 95th Congr., 2d Sess., Mar. 1978 Prepared by the Library of Congr., Congressional Res. Service (GPO-23-254) Avail: SOD HC

A preliminary report, based on FY 1976 funding data, was completed in October 1977. This report is an extension of the earlier report; the major objective is to focus upon the interrelationships between the environment and energy development and use. A summary of FY 1977 R and D funding in the matrix format developed in the earlier study is presented. A

series of environmental-energy issues are defined and a number of questions for each are posed. Two appendices are included: (1) a brief discussion of environmental factors that are included in the matrix and a discussion of the respective fuel cycles; (2) a summary of hearings on the coal and nuclear fuel cycles held before the Subcommittee on the Environment and the Atmosphere. G.Y.

**N79-17340#** UOP, Inc., Des Plaines, Ill.

### **OPTIMIZATION OF PDOPED KOCITE (TRADE NAME) ELECTRODES IN H3PO4 FUEL CELLS Interim Progress Report, 28 Jan. 1978 - 28 Jul. 1978**

L. B. Welsh, R. W. Leyerly, and D. M. Preston Aug. 1978 54 p refs

(Contract DAAG53-76-C-0014; DA Proj. 1G7-62708-AH-67) (AD-A061242; IPR-5) Avail: NTIS HC A04/MF A01 CSCL 10/2

The use of UOP Inc. Kocite electrocatalysts as low-cost air and/or fuel electrocatalysts in phosphoric acid electrolyte fuel cells is being optimized with respect to some of the electrocatalyst and electrode structure parameters. Kocite electrocatalysts are made from Kocite materials, which are composite structures consisting of pyropolymers chemically bonded to refractory substrates. Fuel cell electrodes are fabricated from these electrocatalysts and normally tested as anodes and cathodes in model fuel cells. GRA

**N79-17341#** Burns and Roe, Inc., Woodbury, N. Y.

### **USAF TERRESTRIAL ENERGY STUDY. VOLUME 3, PART 1: SUMMARY DATA DISPLAY Final Report, 1 Apr. 1978 - 1 Feb. 1978**

David C. Hall, A. Carlson, D. Fuller, R. Reyer, C. Mallner, S. Fogelson, and M. Novak May 1978 390 p refs

(Contract F33615-76-C-2171; AF Proj. 3145) (AD-A061071; AFAPL-TR-78-19-Vol-3-Pt-1) Avail: NTIS HC A17/MF A01 CSCL 10/2

This report was prepared to serve as a guide for the U.S. Air Force in selecting types of energy conversion systems to meet their future ground power requirements. The electric power requirements included in this report range from 10 kilowatts to 50 megawatts. Twenty-one types of systems, conventional as well as advanced, are considered. These include 19 types of energy conversion systems which utilize either chemical fuel, nuclear fuel, solar energy or wind energy and two types of energy storage systems which utilize electric power for recharging. Each system is characterized in terms of a set of economic, physical and performance parameters including acquisition costs, life cycle costs, size, efficiency and environmental constraints. A total of eighteen such parameters are presented for each type of system for several sets of requirements. The requirements are defined in terms of electric power level, voltage level, frequency and duration of operation corresponding to typical U.S. Air Force ground applications. GRA

**N79-17344#** Brown, Boveri und Cie, A.G., Heidelberg (West Germany). Zentrales Forschungslab.

### **DEVELOPMENT OF HIGH TEMPERATURE FUEL CELL BATTERY Final Report**

Hubert Holick, Herbert Kleinschmager, Rudolf Krapf, Armin Minor, and Franz-Josef Rohr Dec. 1977 265 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Forsch. u. Technol.

(BMFT-FB-T-77-17) Avail: NTIS HC A12/MF A01; ZLDI, Munich DM 57.10

Proceeding from the basic investigation of single cells, research work was performed with high temperature fuel cell batteries containing ZrO<sub>2</sub> solid electrolytes. The main objective was to develop multicell modules and the associated joining technology as well as the development of auxiliary equipment for the operation of the batteries. Modules of 30 tube-shaped in-series connected cells and the subsequently built small battery units as well as the auxiliary equipment necessary for the reformation of natural gas were tested successfully at working temperatures of 1000 C. Experimental cells were operated for more than 22,000 hours at temperatures of 1000 C and under

permanent load. The decrease in voltage and performance was minimal.

G.Y.

**N79-17348#** National Technical Information Service, Springfield, Va.

**SOLAR WATER PUMPS. CITATIONS FROM THE ENGINEERING INDEX DATA BASE** Progress Report, 1970 - Nov. 1978

Audrey S. Hundemann Dec. 1978 46 p  
(NTIS/PS-78/1288/6; NTIS/PS-77/1161) Avail: NTIS HC \$28.00/MF \$28.00 CSCL 02C

Design concepts and the technical and economic feasibility of using solar energy to pump water are discussed. The use of solar heat actuated Rankine cycle engines and free cylinder Stirling engines for solar powered water pumps, pumps driven by photovoltaic modules, and application of solar pumps to irrigation and electric power generation were studied. This updated bibliography contains 40 abstracts, 9 of which are new entries to the previous edition.

GRA

**N79-17349#** Rutgers - The State Univ., Piscataway, N.J. Dept. of Electrical Engineering.

**SILICON SCHOTTKY PHOTOVOLTAIC DIODES FOR SOLAR ENERGY CONVERSION** Annual Progress Report, 1 Jan. - 31 Dec. 1977

Wayne A. Anderson Jan. 1978 5 p refs Prepared in cooperation with ERDA, Washington, D.C.  
(Contract NSF/AER-73-03197)

(PB-287417/0; NSF/RANN/SE/AER73-03197/PR-77;  
NSF/RA-780267) Avail: NTIS HC A02/MF A01 CSCL 10B

Work accomplished on a research study involving a five fold plan to achieve 12.5 percent efficiency and apply the Schottky process to more economical silicon substrates is reported. A study of the interfacial insulating layer was made to correlate layer thickness and composition with solar cell performance. Scanning electron microscope and Auger spectrographic analyses were used with electronic tests to investigate this effect. Processing variables were studied using substrate heating, substrate biasing, and sputtered-top metal layers. The Schottky process was applied to ribbon silicon and polysilicon to investigate the efficiency as applied to continuous fabrication techniques.

GRA

**N79-17350#** National Bureau of Standards, Washington, D.C. Solar Criteria and Standards Program.

**ENVIRONMENTAL AND SAFETY CONSIDERATIONS FOR SOLAR HEATING AND COOLING APPLICATIONS**

Sep. 1978 34 p refs Sponsored in part by HUD  
(Contract DOE-EA-77-A-01-6010)

(PB-287772/8; NBSIR-78-1532) Avail: NTIS HC A03/MF A01 CSCL 13A

The HUD Minimum Property Standards (MPS) and the residential and commercial interim performance criteria (IPC) prepared by the National Bureau of Standards address many health and safety considerations that need to be considered by solar heating and cooling system designers. For example, factors such as the toxicity and flammability of heat transfer fluids are often not considered in the design of systems. Similarly, attention is seldom paid to the safe disposal of these fluids. These problems are compounded by the lack of clear guidelines as to which fluids constitute hazards that warrant special consideration. This report is intended to create an increased sense of awareness of the health and safety aspects of solar heating and cooling applications by extracting and amalgamating pertinent provisions of the MPS and IPC documents. Some of the areas that are addressed include: structural safety, heat transfer fluid toxicity and flammability considerations including the protection of potable water, effects of solar equipment on the fire resistance of buildings, and protection from physical hazards.

GRA

**N79-17351#** National Bureau of Standards, Washington, D.C. Building Economics and Regulatory Technology Div.

**STATE-OF-THE-ART STUDY OF HEAT EXCHANGERS USED WITH SOLAR ASSISTED DOMESTIC HOT WATER SYSTEMS (POTENTIAL CONTAMINATION OF POTABLE WATER SUPPLY)** Final Report

F. Eugene Metz and Mary Jane Orlowski Oct. 1978 82 p refs Sponsored in part by DOE  
(PB-287410/5; NBSIR-78-1542) Avail: NTIS HC A05/MF A01 CSCL 13A

The results are presented of a nonquantitative state-of-the-art with solar assisted domestic hot water systems where a heat exchanger interface exists between the potable water supply and heat transfer fluid. Emphasis is placed on the potential for contaminating the potable water supply if failures should occur. The study considers (1) characteristics of various heat exchanger types and their relative safety; (2) characteristics of heat exchanger fluids (toxicity, corrosivity, thermal properties, etc.); (3) regulatory considerations; and (4) designs of similar systems with potential for contamination.

GRA

**N79-17352#** National Bureau of Standards, Washington, D.C. Electron Devices Div.

**MEASUREMENT TECHNIQUES FOR SOLAR CELLS** Quarterly Report, 1 Jan. 1978 - 31 Mar. 1978

D. E. Sawyer, H. K. Kessler, and H. A. Schafft Sep. 1978 18 p refs Sponsored in part by DOE  
(PB-287519/3; NBSIR-78-1513) Avail: NTIS HC A02/MF A01 CSCL 10B

A technique is set forth which employs forward-biasing solar cells during scanning to pin-point certain cell defects and to obtain values of cell quantities such as emitter sheet resistance. An analysis appropriate for laser scanning forward-biased cells with a line source is presented. Results from initial experiments suggest that the new technique should work quite well on real-world solar cells. Apparatus development work included the design and initial construction of a high-sun insolation source for forward-biasing cells by light while scanning, and the construction of a matching network to couple the low-impedance illuminated cell to the scanned display electronics. The announcement and program for the May 1-3, 1978 Workshop on the Stability of (Thin Film) Solar Cells and Materials at NBS is presented.

GRA

**N79-17353#** Pennsylvania State Univ., University Park. Inst. for Research on Land and Water Resources.

**WATER/ENERGY MANAGEMENT AND EVALUATION MODEL FOR PENNSYLVANIA** Completion Report

Terrence L. Elchak, David L. Raphael, James P. Ignizio, and Hector H. Martinez Sep. 1978 146 p refs  
(Contract DI-14-34-0001-7080; OWRT Proj. A-048-PA(3))  
(PB-287577/1; W79-00007) Avail: NTIS HC A07/MF A01 CSCL 10A

An interactive water/energy model is presented for the state of Pennsylvania. An independent water model and energy model are jointed to show the interactions between energy supply and demand with the supply of water. These interactions are depicted by water use functions for various energy sectors. Specific examples are presented for the electrical generation sectors. Two hypothetical scenarios are presented to show the use of the model as a planning tool.

GRA

**N79-17354#** Rosenstiel School of Marine and Atmospheric Sciences, Miami, Fla. Div. of Biology and Living Resources. **PHOTOPRODUCTION OF HYDROGEN BY MARINE BLUE-GREEN ALGAE** Annual Progress Report, 15 Dec. 1977 - 15 Jun. 1978

Akira Mitsui 15 Jun. 1978 71 p refs  
(Grant NSF AER-77-11545)  
(PB-287508/6; NSF/RA-780272) Avail: NTIS HC A04/MF A01 CSCL 06A

The biological and biochemical photoproduction of hydrogen was studied for use as an alternate fuel. Earlier investigations found an organism which exhibits exceptionally high hydrogen producing capabilities in the form of a blue-green algal strain, Miami BG7.F were performed to reveal the mechanisms of

N79-17364

hydrogen production in this strain and to determine whether the efficiency of hydrogen production can attain levels required for applied projects. Emphasis in research shifted from the study of metabolic inhibitors of hydrogen production to a study of the enzyme systems which catalyze hydrogen production. It was discovered that hydrogen evolution by Miami BG7 involves the participation of both hydrogenase and nitrogenase, with the latter appearing as the major contributor of the hydrogen production. However, Miami BG7 does not appear to exhibit hydrogenase activity. The effects of light intensity, temperature, and pH were tested and optimum conditions for hydrogen photoproduction were determined. It was found that the regulation of specific environmental parameters could lead to marked changes in the quantum efficiency of hydrogen production. A brief background review and discussion of hydrogen photoproduction is given with an approach to hydrogen production research. GRA

N79-17364# Hittman Associates, Inc., Columbia, Md.

**ENVIRONMENTAL ASSESSMENT DATA BASE FOR COAL LIQUEFACTION TECHNOLOGY. VOLUME 1: SYSTEMS FOR 14 LIQUEFACTION PROCESSES** Final Report, Feb. 1977 - Aug. 1978

Craig S. Koralek and Subhash S. Patel Sep. 1978 204 p refs 2 Vol.

(Contract EPA-68-02-2162)

(PB/287799/1: EPA-600/7-78-184A)

Avail: NTIS

HC A10/MF A01 CSCL 07A

Pertinent information about 14 prominent coal liquefaction systems now being developed are summarized. For each system, a brief description, a flow diagram, and a list of materials entering and leaving the system is presented. Potential applicable control techniques are described generally, along with the current status and development plans for the 14 systems. Results indicate that these processes are not environmentally defined in the published literature; however, there is some indication that current development plans may help to correct this situation. GRA

N79-17365# Hittman Associates, Inc., Columbia, Md.

**ENVIRONMENTAL ASSESSMENT DATA BASE FOR COAL LIQUEFACTION TECHNOLOGY. VOLUME 2: SYNTHOIL, H-COAL, AND EXXON DONOR SOLVENT PROCESSES** Final Report, Feb. 1977 - Aug. 1978

C. Leon Parker and Dewey I. Dykstra Sep. 1978 482 p refs 2 Vol.

(Contract EPA-68-02-2162)

(PB/287800/7: EPA-600/7-78-184B)

Avail: NTIS

HC A21/MF A01 CSCL 07A

An environmental characterization of three selected coal liquefaction systems: Synthoil, H-Coal, and Exxon Donor Solvent are presented. Existing environmentally significant data are documented and evaluated. Estimates are given for the raw waste streams, treatment and control processes, treated waste stream discharges, and the effects of these discharges on the environment. Conclusions include: (1) carbon-containing residues from process phase separations are major potential environmental problems; (2) except for solid carbon-containing residues from phase separations, treatment and controls exist for removing most major waste components--however, their efficiency in controlling coal liquefaction waste streams needs to be tested; and (3) less attention was addressed to trace organic and inorganic compounds. GRA

N79-17366# National Oceanic and Atmospheric Administration, Boulder, Colo.

**ENVIRONMENTAL ASSESSMENT OF THE ALASKAN CONTINENTAL SHELF. VOLUME 1: BIOLOGICAL STUDIES** Final Reports

Jun. 1978 494 p refs Sponsored in part by Bureau of Land Management 3 Vol.

(PB-289154/7: NOAA-78110701)

Avail: NTIS

HC A21/MF A01 CSCL 13B

The aquatic fauna and ecology of the Alaskan Continental Shelf which assess the environmental effects of petroleum developments in the area are reported. Lethal and sublethal effects on selected Alaskan marine species after acute and long-term exposure to oil and oil components; food and feeding re-

lationships in the benthic and demersal fishes of the Gulf of Alaska and Bering Sea; Marine Birds of Alaska; determination and description of knowledge of the distribution, abundance, and timing of salmonids in the Gulf of Alaska and Bering Sea; Ichthyoplankton of the Eastern Bering Sea; Environmental Assessment of the Southeastern Bering Sea; Zooplankton Microneuston; and trawl survey of the epifaunal invertebrates of Norton Sound, Southeastern Chuckchi Sea, and Kotzebue Sound were studied. GRA

N79-17367# National Oceanic and Atmospheric Administration, Boulder, Colo.

**ENVIRONMENTAL ASSESSMENT OF THE ALASKAN CONTINENTAL SHELF. VOLUME 2: BIOLOGICAL STUDIES**

Final Report

Jun. 1978 960 p Sponsored in part by Bureau of Land Management 3 Vol.

(PB-289155/4: NOAA-78110702)

Avail: NTIS

HC A99/MF A01 CSCL 13B

The aquatic fauna and ecology of the Alaskan Continental Shelf which assesses the environmental effects of petroleum developments in that area are reported. Demersal fish and shellfish resources of the Gulf of Alaska from Cape Spencer to Unimak Pass were studied. GRA

N79-17368# National Oceanic and Atmospheric Administration, Boulder, Colo.

**ENVIRONMENTAL ASSESSMENT OF THE ALASKAN CONTINENTAL SHELF. VOLUME 3: BIOLOGICAL STUDIES**

Final Report

Jun. 1978 623 p refs Sponsored in part by Bureau of Land Management 3 Vol.

(PB-289156/2: NOAA-78110703)

Avail: NTIS

HC A99/MF A01 CSCL 13B

The aquatic fauna and ecology of the Alaskan Continental Shelf which assess the environmental effects of petroleum developments in that area are reported. Community structure, distribution, and interrelationships of marine birds in the Gulf of Alaska; reconnaissance of the intertidal and shallow subtidal biotic lower Cook inlet; and airborne multispectral mapping of the intertidal zone of Southern Alaska were studied. GRA

N79-17374# National Oceanic and Atmospheric Administration, Boulder, Colo. Outer Continental Shelf Environmental Assessment Program.

**MARINE BIOLOGICAL EFFECTS OF OCS PETROLEUM DEVELOPMENT**

Douglas A. Wolfe Sep. 1978 335 p Sponsored in part by Bureau of Land Manag., Wash., D.C. and EFA, Wash., D.C.

(PB-288935/0: NOAA-TM-ERL-OCSEAP-1: NOAA-78102601)

Avail: NTIS HC A15/MF A01 CSCL 13B

The proceedings of the first formal scientific review of the Biological Effects Studies managed by NOAA's Outer Continental Shelf Environmental Assessment Program (OCSEAP) were Documented. Bureau of Land Management Environmental Studies Program in support of OCS leasing for Alaskan oil and gas development and NOAA's Energy Resources Project on Fate and Effects of Petroleum Hydrocarbons in Marine Ecosystems and Organisms were studied. Selected topics and a brief synopsis of general comments received from the invited outside reviewers are discussed. GRA

N79-17378# Industrial Environmental Research Lab., Research Triangle Park, N. C.

**EPA PROGRAM CONFERENCE REPORT: COAL CLEANING, AN OPTION FOR INCREASED COAL UTILIZATION**

Final Report

R. E. Balzhiser, A. W. Deurbrauck, S. J. Gage, L. Hoffman, G. A. Isaacs, J. D. Kilgroe, H. Loesch, J. F. McConnell, J. Mullin, J. H. Oxley et al Aug. 1978 149 p refs Conf. held at Arlington, Va., 24-25 May 1977 Prepared in cooperation with Battelle Columbus Labs., Ohio

(Grant EPA-R-805374)

(PB-288223/1: EPA-600/7-77-130)

Avail: NTIS

HC A07/MF A01 CSCL 08I

The following topics are discussed: (1) the importance of coal in meeting national energy needs; (2) economics and technology of coal utilization; (3) regional and institutional perspectives; (4) environmental perspectives; (5) coal cleaning applications for SO<sub>2</sub> emission control; (6) engineering/economic analyses of coal preparation with SO<sub>2</sub> cleanup processes for keeping higher sulfur coals in the energy market; (7) the EPA region 4 TVA study; (8) the Homer City experience; and (9) coal cleaning- a vehicle for more effective coal utilization. Panel discussion and concluding remarks are also presented. G.Y.

**N79-17744#** National Bureau of Standards, Washington, D. C. Building Economics and Regulatory Technology Div.

**LIFE-CYCLE COSTING. A GUIDE FOR SELECTING ENERGY CONSERVATION PROJECTS FOR PUBLIC BUILDINGS**

**Final Report**

Rosalie T. Ruegg, John S. McConaughey, G. Thomas Sav, and Kimberly A. Hockenberry Sep. 1978 84 p refs Sponsored in part by DOE

(PB-287804/9: NBS-BSS-113) Avail: NTIS HC A05/MF A01 CSCL 05C

A step-by-step guide is presented for using life-cycle costing analysis to evaluate and rank the cost effectiveness of alternative energy conservation retrofit projects to existing public buildings; and to select the most cost-effective design for new buildings. Worksheets, illustrated with a realistic example, and a computer program are provided. This guide is compatible with a life-cycle costing guide prepared for the Department of Energy for use in the Federal Energy Management Program by Federal Agencies and is intended as an aid to state and local governments for use in their energy conservation programs. GRA

**N79-17859#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**COLD-AIR PERFORMANCE OF FREE POWER TURBINE DESIGNED FOR 112-KILOWATT AUTOMOTIVE GAS-TURBINE ENGINE. 2: EFFECTS OF VARIABLE STATOR-VANE-CHORD SETTING ANGLE ON TURBINE PERFORMANCE** Final Report

Kerry L. McLallin and Milton G. Kofsky Feb. 1979 53 p refs

(Contract EC-77-A-31-1011) (NASA-TM-78993: DOE/NASA/1011-78/28: E-9775) Avail: NTIS HC A04/MF A01 CSCL 21A

The cold-air performance of an axial-flow power turbine with a variable stator designed for a 112-kW automotive gas-turbine engine was determined at speeds from 30 to 110 percent of design and at pressure ratios from 1.11 to 2.67. Performance is presented in terms of equivalent mass flow, torque, power, and efficiency for stator-vane-chord setting angles of 26 degs, 30 degs, 35 degs (design), 40 degs, 45 degs, and 50 degs. Turbine braking performance at a nominal stator setting angle of 107 degs is also presented. Turbine efficiency increased with increasing stator setting angle. A 10-point efficiency increase was obtained by opening the stator from the design setting angle of 35 degs to a setting angle of 45 degs. Author

**N79-17890#** Lockheed Missiles and Space Co., Sunnyvale, Calif.

**THE 25 kW POWER MODULE EVOLUTION STUDY. PART 3: CONCEPTUAL DESIGNS FOR POWER MODULE EVOLUTION. VOLUME 2: PROGRAM PLANS**

**Final Report**

27 Jan. 1979 90 p refs (Contract NAS8-32928)

(NASA-CR-161146: LMSC-D614944-Pt-3-Vol-2) Avail: NTIS HC A05/MF A01 CSCL 22A

A plan is presented for the evolutionary development and deployment of the power module system with performance capabilities required to support the 1983 to 1990 user requirements. Aspects summarized include program functional, operational, and hardware elements; program work breakdown and specification items; development plans and schedules for developmental and technology milestones; test concepts and timeliness; and ground and orbit operations concepts. A.R.H.

**N79-17896#** Raytheon Co., Wayland, Mass. Equipment Div. **SOLAR POWER SATELLITE (SPS) PILOT BEAM AND COMMUNICATION LINK SUBSYSTEM INVESTIGATION STUDY, PHASE 1 Final Report**

31 Jan. 1979 85 p

(Contract NAS8-33157)

(NASA-CR-161161: ER79-4032)

Avail: NTIS

HC A05/MF A01 CSCL 22B

A preliminary engineering model of ionospheric interactions with the pilot beam was established and used to demonstrate that the dual frequency baseline pilot beam system might not be viable in the presence of an unstable transmission path. Alternate approaches to remove this difficulty are described. Although ionospheric fluctuations will not significantly degrade beam pointing or raise the sidelobe levels, they will reduce transmission efficiency by upwards of 25%. Mitigating strategies to substantially reduce this effect are proposed. Based on the Klystron noise spectrum, the pilot beam transmitter power was determined as a function of frequency offset from the power beam carrier frequency. The RFI from the pilot beam, on the ground and at geosynchronous orbit is shown. Noise levels on the earth's surface due to the SPS are presented as a function of frequency and the number of SPS systems. Analysis of the communication subsystem indicates that a standard telemetry line of 1.544 MB/s would satisfy both voice and data link requirements. Additional links would be required for TV and radio transmissions.

A.R.H.

**N79-17897#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**CHANGES IN THE TERRESTRIAL ATMOSPHERE-IONOSPHERE-MAGNETOSPHERE SYSTEM DUE TO ION PROPULSION FOR SOLAR POWER SATELLITE PLACEMENT**

S. A. Curtis and J. M. Grebowsky Feb. 1979 35 p refs Submitted for publication

(NASA-TM-79719) Avail: NTIS HC A03/MF A01 CSCL 22B

Preliminary estimates of the effects massive Ar(+) injections on the ionosphere-plasmasphere system with specific emphasis on potential communications disruptions are given. The effects stem from direct Ar(+) precipitation into the atmosphere and from Ar(+) beam induced precipitation of MeV radiation belt protons. These injections result from the construction of Solar Power Satellites using earth-based materials in which sections of a satellite must be lifted from low earth to geosynchronous orbit by means of ion propulsion based on the relatively abundant terrestrial atmospheric component, Ar. The total amount of Ar(+) injected in transporting the components for each Solar Power Satellite is comparable to the total ion content of the ionosphere-plasmasphere system while the total energy injected is larger than that of this system. It is suggested that such effects may be largely eliminated by using lunar-based rather than earth-based satellite construction materials.

J.M.S.

**N79-17898#** Battelle Columbus Labs., Ohio.

**EARTH ORBITAL ASSESSMENT OF SOLAR ELECTRIC AND SOLAR SAIL PROPULSION SYSTEMS**

R. R. Teeter 30 Sep. 1977 78 p refs

(Contract NASw-2018)

(NASA-CR-158167: BMI-NLVP-TM-77-2)

Avail: NTIS

HC A05/MF A01 CSCL 22B

The earth orbital applications potential of Solar Electric (Ion Drive) and Solar Sail low-thrust propulsion systems are evaluated. Emphasis is placed on mission application in the 1980s. The two low-thrust systems are compared with each other and with two chemical propulsion Shuttle upper stages (the IUS and SSUS) expected to be available in the 1980s. The results indicate limited Earth orbital application potential for the low-thrust systems in the 1980s (primarily due to cost disadvantages). The longer term potential is viewed as more promising. Of the two systems, the Ion Drive exhibits better performance and appears to have better overall application potential.

Author

**N79-17984** British Library Lending Div., Boston Spa (England).

**ELECTROLYSIS OF ZINC. STATISTICAL MODEL OF THE PROCESS PARAMETERS FOR AN INDUSTRIAL CELL**

A. DEste Oct. 1978 19 p refs Transl. into ENGLISH from

Met. Italiana (Italy), no. 4, 1977 p 133-138  
(BLL-RTS-11317) Avail: British Library Lending Div., Boston Spa, Engl.

The energy balance of an industrial cell for the electrolysis of zinc is examined as a function of the chemical composition of the electrolyte and the physical parameters characterising the process. A factorial experiment was carried out and the following independent variables were considered: electrolyte temperature; time of deposition; current density; electrolyte flow; impurities concentration; organic additives; sulphuric acid; and zinc concentrations. The results of the experiment were computed using a special multiple regression method. The results of the analysis, were used for construction of a mathematical model representing a higher degree of approximation of the effects of each of the independent variables and the interaction of selected dependent variables. S.E.S.

**N79-18057#** Union Carbide Corp., Tonawanda, N.Y.  
**STUDY OF HYDROGEN RECOVERY SYSTEMS FOR GAS VENTED WHILE REFUELING LIQUID-HYDROGEN FUELED AIRCRAFT**

C. R. Baker Feb. 1979 70 p refs  
(Contract NAS1-14698)  
(NASA-CR-158991) Avail: NTIS HC A04/MF A01 CSCL 21P

Methods of capturing and reliquefying the cold hydrogen vapor produced during the fueling of aircraft designed to utilize liquid hydrogen fuel were investigated. An assessment of the most practical, economic, and energy efficient of the hydrogen recovery methods is provided. S.E.S.

**N79-18061#** KVB Engineering, Inc., Tustin, Calif.  
**LOW-SULFUR WESTERN COAL USE IN EXISTING SMALL AND INTERMEDIATE SIZE BOILERS** Final Report, Feb. 1975 - Feb. 1978

Kenneth L. Maloney, George L. Moilanen, and P. L. Langsjoen Jul. 1978 444 p.  
(Contract EPA-68-02-1863)  
(PB-287937/7; EPA-600/7-78-153A) Avail: NTIS HC A19/MF A01 CSCL 21D

Western subbituminous coals can be substituted for eastern bituminous coals as an industrial boiler fuel and are compatible with industrial coal-fired units of current design. Two unit types of older design (underfed and traveling grate stokers) experienced difficulty burning western coal. Superiority to eastern coals was demonstrated in terms of SO<sub>x</sub>, NO<sub>x</sub>, particulate, and unburned HC emissions. Western coals could be fired at lower excess air and exhibited substantially lower combustible losses than eastern coals. The size of delivered western coal was a problem in most of the stoker-fired units tested: it generally had too large a percentage of fine coal, caused by its poor weathering characteristics. Stoker performance on western coal can be improved by sizing the coal at the point of use, to reduce delivery distances to about 200 miles. GRA

**N79-18287#** National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

**TRANSIENT SHUTDOWN ANALYSIS OF LOW-TEMPERATURE THERMAL DIODES**  
Richard J. Williams Mar. 1979 21 p refs  
(NASA-TP-1369; A-7642) Avail: NTIS HC A02/MF A01 CSCL 20D

The various thermal diodes available for use in cryogenic systems are described. Two diode types, liquid-trap and liquid-blockage diodes, were considered to be the most attractive, and thermal models were constructed to predict their behavior in the reverse mode. The diodes, which are of similar size and throughput, were also examined experimentally in a parallel test setup under nominally identical conditions. Their characteristics were ascertained in terms of forward-mode and reverse-mode conductances, shutdown times and energies, and recovery to forward-mode operation with ethane as the working fluid in the temperature range 170 K to 220 K. Results show that the liquid-blockage diode is the quicker of the two diodes to shut

down from the forward mode (8 min as opposed to 10 min). However, the liquid-blockage diode has a larger reverse-mode conductance which results in a greater overall evaporator temperature rise. The importance of the relative size and heat inputs to the condenser/reservoir configuration of the liquid-blockage diode and the evaporator/trap configuration for the liquid-trap diode are demonstrated. Also included are data which show the susceptibility of the diodes to recovery to forward-mode operation. Guidelines for the choice of a particular diode for an actual application are given. J.M.S.

**N79-18352#** Environmental Protection Agency, Washington, D.C.  
Vitro Lab. Div.

**ENERGY ENVIRONMENT III**

Oct. 1978 259 p refs Proc. of the 3rd Natl. Conf. on the Interagency Energy/Environment R and D Program, Washington, D. C., 1-2 Jun. 1978 Sponsored by EPA  
(EPA-600/9-78-022) Avail: NTIS HC A12/MF A01

The Interagency Energy/Environment R and D Program unites more than a dozen agencies to ensure that unresolved environmental issues are not a barrier to timely and safe development of national energy resources. To this end, the EPA has invested money each year in the Program since its inception in FY 1975. Substantial progress was made toward achieving the goals. Selected achievements were reviewed at the Third National Conference on the Interagency Energy/Environment R and D Program, convened in Washington, D. C., on June 1 and 2, 1978. These proceedings are a result of the conference. Energy/Environment 3 provides an update of interagency research in particular areas, including health effects, transport processes, ecological effects, mining methods and reclamation, control technology, and integrated technology assessment. This report consists of the addresses, papers, and panel discussions of the conference.

**N79-18353#** Environmental Protection Agency, Research Triangle Park, N.C. Health Effects Research Lab.

**STATUS OF BIOSCREENING OF EMISSIONS AND EFFLUENTS FROM ENERGY TECHNOLOGIES**

Michael D. Waters and James L. Epler (Oak Ridge National Lab.) In Automation Industries, Inc. Energy/Environment 3 Oct. 1978 p 29-50 refs

Avail: NTIS HC A12/MF A01.

Short-term tests with bacteria and yeast mutagenicity assays appear to detect effectively the mutagenic potential of complex environmental or industrial effluents; however, chemical fractionation is necessary to reduce toxicity and concentrate hazardous materials. Extension of the results to higher organisms appears to be valid but needs more testing. The results of the feasibility studies discussed show that biological testing can be carried out with complex organic materials but perhaps only when coupled with the appropriate analytical separation schemes. The primary use that combined chemical and biological work may serve is to aid in isolating and identifying the specific classes or components involved. A number of precautions are listed. G.Y.

**N79-18358#** Environmental Protection Agency, Duluth, Minn. Environmental Research Lab.

**ECOLOGICAL EFFECTS OF COAL-FIRED STEAM-ELECTRIC GENERATING STATIONS**  
Gary E. Glass In Automation Industries, Inc. Energy/Environment 3 Oct. 1978 p 121-149 refs

Avail: NTIS HC A12/MF A01

The National Energy Plan recommends an increase of 80% in the use of coal for electricity generation. Such an increase will lead to the construction of many more coal-fired generating facilities. A complete understanding of the effects of such facilities on their surroundings is critical to the agencies responsible for their planning. The research program developed by the Environmental Protection Agency to meet this need is in the third year of a five-year plan. A holistic approach was taken in the design of the program and projects were funded for mining, transportation

and storage, and combustion of coal. Several studies are discussed which deal with these areas and their effects on the environment.

G.Y.

**N79-18359#** Environmental Protection Agency, Cincinnati, Ohio. Environmental Research Lab.

**METHODS FOR THE CONTROL OF ENVIRONMENTAL DAMAGE CAUSED BY MINING ENERGY PRODUCING MATERIALS**

Ronald D. Hill, Eugene F. Harris, and S. Jackson Hubbard *In* Automation Industries, Inc. Energy/Environment 3 Oct. 1978 p 165-185 refs

Avail: NTIS HC A12/MF A01

Some of the environmental pollution problems associated with the mining of coal, uranium, and shales (oil) are addressed and the methods for controlling such pollutions are discussed. G.Y.

**N79-18361#** Environmental Protection Agency, Research Triangle Park, N.C. Industrial Environmental Research Lab.

**INTERAGENCY COAL CLEANING TECHNOLOGY DEVELOPMENT**

James D. Kilgroe and Richard E. Hucko (Department of Energy, Pittsburgh) *In* Automation Industries, Inc. Energy/Environment 3 Oct. 1978 p 221-251 refs

Avail: NTIS HC A12/MF A01

Expanding coal production and use is a major goal of the National Energy Policy. A corollary goal is the containment of adverse environment effects from coal use. This paper presents an overview of regulatory activities related to coal cleaning. An analysis of future coal cleaning R and D priorities is presented. A summary of progress on the interagency coal cleaning R and D program is also presented.

G.Y.

**N79-18365#** Department of Energy, Washington, D. C. Energy Technology Branch.

**FLUIDIZED-BED COMBUSTION**

Steven I. Freedman *In* Automation Industries, Inc. Energy/Environment 3 Oct. 1978 p 313-321

Avail: NTIS HC A12/MF A01

Many people have become interested in solar energy as a goal for clean, efficient, practical, economic generation of heat and power. A prepackaged, aged, concentrated solar energy is available, coal. Fluidized bed combustion is one of the advanced concepts for the clean combustion of coal. This report discusses operating a fluidized bed steam generator on coal.

G.Y.

**N79-18368#** Oklahoma Univ., Norman.

**TECHNOLOGY ASSESSMENT OF WESTERN ENERGY RESOURCE DEVELOPMENT**

Irvin L. White *In* Automation Industries, Inc. Energy/Environment 3 Oct. 1978 p 371-380 refs

Avail: NTIS HC A12/MF A01

An overview is given of the Western Energy Study, the objectives it is intended to achieve, how it is structured and conducted, and the kinds of results it is producing. Water availability was chosen to demonstrate how the problems and issues were identified and defined for policymakers, how this led to additional analysis to identify alternative courses of action, and how these alternatives were analyzed to inform policymakers. The water and dollar cost of energy tradeoffs associated with the choice of cooling options is illustrated. Knowing these tradeoffs, both public and private sector policymakers can make better informed choices.

G.Y.

**N79-18373#** Geological Survey, Denver, Colo.

**LATE DIAGENETIC INDICATORS OF BURIED OIL AND GAS. 2: DIRECT DETECTION EXPERIMENT AT CEMENT AND GARZA FIELDS, OKLAHOMA AND TEXAS, USING ENHANCED LANDSAT 1 AND 2 IMAGES**

Terrence J. Donovan, Patricia A. Termain, and Mitchell E. Henry, Principal Investigators 1979 49 p refs Sponsored by NASA

Original contains color imagery. Original photography may be purchased from the EROS Data Center, Sioux Falls, S. D. 57198 ERTS

(E79-10099: NASA-CR-158055; Rept-79-243) Avail: NTIS HC A03/MF A01 CSCL 08G

The author has identified the following significant results. The Cement oil field, Oklahoma, was a test site for an experiment designed to evaluate LANDSAT's capability to detect an alteration zone in surface rocks caused by hydrocarbon microseepage. Loss of iron and impregnation of sandstone by carbonate cements and replacement of gypsum by calcite were the major alteration phenomena at Cement. The bedrock alterations were partially masked by unaltered overlying beds, thick soils, and dense natural and cultivated vegetation. Interpreters, biased by detailed ground truth, were able to map the alteration zone subjectively using a magnified, filtered, and sinusoidally stretched LANDSAT composite image; other interpreters, unbiased by ground truth data, could not duplicate that interpretation.

**N79-18424#** Michigan State Univ., East Lansing. Remote Sensing Project.

**IDENTIFICATION OF WOOD ENERGY RESOURCES IN CENTRAL MICHIGAN**

William D. Hudson and Kyle Kittleson Nov. 1978 37 p refs (Grant NGL-23-004-083) (NASA-CR-158130) Avail: NTIS HC A03/MF A01 CSCL 02F

Existing biomass studies were compiled for determining their applicability in measuring forest biomass in an entirely new way. Over sixty tree-weight tables were prepared from existing tables or formulas. An estimate of forest biomass was made on a defined area by using Landsat Satellite data analysis, existing forest cover type maps and actual weighting of the entire biomass. Control plots were cruised for normal volume data and weight data, harvested and weighed to determine actual tonnage yields.

S.E.S.

**N79-18439** British Library Lending Div., Boston Spa (England). **THE OPTIMUM VOLTAGE FOR BATTERIES USED IN STANDBY LIGHTING SYSTEMS**

Karel Outulny Dec. 1978 8 p Transl. into ENGLISH from Elektrotechnicky obzor (USSR), v. 65, no. 3, 1976 p. 160-162 (BLL-RTS-11512) Avail: British Library Lending Div., Boston Spa, Engl.

Buildings and projects for which the regulations prescribe emergency lighting systems must therefore be equipped with a standby power supply independent of the mains. The source generally used is a system of permanently fixed lead batteries, type J. The initial cost of such a system depends to a large extent on the chosen battery voltage. The relationship between the installation cost and the battery voltage are described. The aim of the paper is to establish the voltage at which these costs are at a minimum.

G.Y.

**N79-18442** British Library Lending Div., Boston Spa (England). **THE WORLD BALANCE FOR ENERGY NEEDS IN VIEW OF YEAR 2000: DEVELOPMENT OF THE PROBLEM AND AREAS INVOLVED, PART 2**

J. R. Frisch 9 Oct. 1978 30 p refs Transl. into ENGLISH from Rev. de l'Energ., v. 28, no. 298, Nov. 1977 p 533-548 In ENGLISH and FRENCH (BLL-Risley-TR-3395-(9091.9F)) Copyright. Avail: British Library Lending Div., Boston Spa, Engl.

Three main conclusions are formed from this detailed analysis: (1) concerns the geographic progression and concentration of consumption; (2) concerns the major role that hydrocarbons will continue to play in maintaining the balance between supply and demand; and (3) brings to light the future contributions of the Third World to the overall formation of requirements. These conclusions are completed by explaining them with reference to a long term view which will enable the year 2000 to be put in perspective at the heart of the historical development of energy.

G.Y.

## N79-18443

**N79-18443\*** National Aeronautics and Space Administration. Pasadena Office, Calif.

### **THERMAL ENERGY TRANSFORMER Patent**

C. Martin Berdahl (JPL) and Carl L. Thiele, inventors (to NASA) (JPL) Issued 23 Jan. 1979 5 p Filed 12 Aug. 1977 Supersedes N77-30616 (15 - 21, p 2824) Sponsored by NASA (NASA-Case-NPO-14058-1; US-Patent-4.135,367; US-Patent-Appl-SN-824024; US-Patent-Class-60-641; US-Patent-Class-60-508; US-Patent-Class-60-572; US-Patent-Class-126-271; US-Patent-Class-165-105) Avail: US. Patent and Trademark Office CSCL 10A

For use in combination with a heat engine, a thermal energy transformer is presented. It is comprised of a flux receiver having a first wall defining therein a radiation absorption cavity for converting solar flux to thermal energy, and a second wall defining an energy transfer wall for the heat engine. There is a heat pipe chamber interposed between the first and second walls having a working fluid disposed within the chamber and a wick lining the chamber for conducting the working fluid from the second wall to the first wall. Thermal energy is transferred from the radiation absorption cavity to the heat engine.

Official Gazette of the U.S. Patent and Trademark Office

**N79-18445#** National Aeronautics and Space Administration. Pasadena Office, Calif.

### **AN IMPROVED SOLAR PANEL AND METHOD FOR FABRICATING THE SAME Patent Application**

Joseph Bonacquisti (RCA Corp., Princeton, New Jersey) and Marvin S. Crouthamel, inventors (to NASA) (RCA Corp., Princeton, New Jersey) Filed 6 Mar. 1979 19 p Sponsored by NASA (Contract JPL-954352)

(NASA-Case-NPO-14490-1; US-Patent-Appl-SN-017884) Avail: NTIS HC A02/MF A01 CSCL 10A

A method for the fabrication of solar panels and in particular laminated solar panels is presented. The method has steps which are particularly adaptable for automation. The solar panel is fabricated by electrically interconnecting a plurality of individual solar cells into a plurality of strings and connecting the plurality of strings into an array. The array is laminated between a pair of transparent plates.

NASA

**N79-18447#** Oak Ridge National Lab., Tenn. Regional and Urban Studies Section.

### **BUILDINGS ENERGY USE DATA BOOK, EDITION 1**

G. E. Liepins, M. A. Smith, A. B. Rose, and K. Haygood Apr. 1978 486 p refs (Contract W-7405-eng-26)

(ORNL-5363) Avail: NTIS HC A21/MF A01

The initial effort is reported of Oak Ridge National Laboratory to develop the document Buildings Energy Use Data Book for use as a desk-top reference for conservation and solar applications, conservation planning and policy. An assembly and display of statistics which characterize current and past energy end use activities in the residential/commercial sector are presented along with data on other factors which influence the residential/commercial sector in the nation. Statistical data on energy use in the residential/commercial sector in the form of tables, graphs, and charts are presented. A large amount of relevant data in an easily retrievable and usable format is presented. The following topics are covered: sector definitions, buildings inventory, appliance inventory, heating and cooling units inventory, appliance efficiencies, structural characteristics, climatological and appliance fuel use, national economic and demographic determinants, fuel consumption and prices, and a survey of selected energy studies. A list of data sources is provided at the end of topic. F.O.S.

**N79-18448#** IBM Federal Systems Div., Huntsville, Ala.

### **SYSTEM INTEGRATION OF MARKETABLE SUBSYSTEMS Progress Reports**

Feb. 1979 61 p Prepared for DOE

(Contract NAS8-32036)

(NASA-CR-161104) Avail: NTIS HC A04/MF A01 CSCL 10B

Progress is reported in the following areas: systems integration of marketable subsystems; development, design, and building of

site data acquisition subsystems; development and operation of the central data processing system; operation of the MSFC Solar Test Facility; and systems analysis.

J.M.S.

**N79-18449#** Wyle Labs., Inc., Huntsville, Ala. Solar Energy Systems Div.

### **THERMAL PERFORMANCE EVALUATION OF MSFC HOT AIR COLLECTORS WITH VARIOUS FLOW CHANNEL DEPTH**

Jan. 1979 19 p refs Prepared for DOE

(Contract NAS8-32036)

(NASA-CR-150900) Avail: NTIS HC A02/MF A01 CSCL 10B

The test procedures used and the results obtained during the evaluation test program on the MSFC air collector with flow channel depth of 3 in., 2 in., and 1 in., under simulated conditions are presented. The MSFC hot air collector consists of a single glass cover with a nonselective coating absorber plate and uses air as the heat transfer medium. The absorber panel consists of a thin flat sheet of aluminum.

J.M.S.

**N79-18450#** Wyle Labs., Inc., Huntsville, Ala. Solar Energy Systems Div.

### **LONG-TERM WEATHERING EFFECTS ON THE THERMAL PERFORMANCE OF THE LIBBEY-OWENS-FORD (LIQUID) SOLAR COLLECTOR**

Jan. 1979 13 p refs Prepared for NASA and DOE

(Contract NAS8-32036)

(NASA-CR-161093) Avail: NTIS HC A02/MF A01 CSCL 10A

Thermal performance tests were conducted on the Libbey-Owens-Ford liquid collector, following long term exposure to natural weathering conditions. Visual inspection of the collector, prior to the retest, indicated noticeable clouding of the inner cover glass, probably resulting from outgassing of the insulation. The absorber plate also showed some discoloration. The test results indicated that performance degradation had occurred at inlet temperatures significantly above ambient. The change in the slope of the efficiency curve, from the original data, is a direct indicator of an increase in the collector heat loss coefficient.

J.M.S.

**N79-18451#** Motorola, Inc., Phoenix, Ariz. Semiconductor Group.

### **PHASE 1 OF THE AUTOMATED ARRAY ASSEMBLY TASK OF THE LOW COST SILICON SOLAR ARRAY PROJECT Final Report**

R. A. Pryor, L. A. Grenon, and M. G. Coleman Jan. 1978 300 p refs Prepared for JPL and DOE

(Contracts NAS7-100; JPL-954363)

(NASA-CR-158120; Rept-2258/8; DOE/JPL-954363-78/8) Avail: NTIS HC A13/MF A01 CSCL 10A

The results of a study of process variables and solar cell variables are presented. Interactions between variables and their effects upon control ranges of the variables are identified. The results of a cost analysis for manufacturing solar cells are discussed. The cost analysis includes a sensitivity analysis of a number of cost factors.

S.E.S.

**N79-18453#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. BLOCK 4 SOLAR CELL MODULE DESIGN AND TEST SPECIFICATION FOR RESIDENTIAL APPLICATIONS

Low-Cost Solar Array Project

1 Nov. 1978 31 p refs Sponsored by NASA and DOE

(NASA-CR-158117; JPL-5101-83; DOE/JPL-1012-78/14)

Avail: NTIS HC A03/MF A01 CSCL 10A

Near-term design, qualification and acceptance requirements are provided for terrestrial solar cell modules suitable for incorporation in photovoltaic power sources (2 kW to 10 kW) applied to single family residential installations. Requirement levels and recommended design limits for selected performance criteria are specified for modules intended principally for rooftop installations. Modules satisfying the requirements of this specification fall into one of two categories, residential panel or residential shingle, both meeting general performance requirements plus additional category peculiar constraints.

L.S.

**N79-18454#** Solar Engineering and Equipment Co., Metairie, La.  
**INSTALLATION PACKAGE FOR A SOLAR HEATING SYSTEM**

Dec. 1978. 70 p. Prepared for DOE  
 (Contract NAS8-32247)  
 (NASA-CR-150876) Avail: NTIS HC A04/MF A01 CSCL 10A

Installation information is given for a solar heating system installed in Concho Indian School at El Reno, Oklahoma. This package includes a system Operation and Maintenance Manual, hardware brochures, schematics, system operating modes and drawings. L.S.

**N79-18456#** Stuttgart Univ. (West Germany). Foreschungsinst. Windenergetechnik.

**EXPERT OPINION ON WIND ENERGY CONVERSION SYSTEMS DESIGNED BY HERMANN HONNEF**  
**Final Report**

Heiner Doerner Dec. 1977 80 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Forsch. u. Technol. (BMFT-FB-T-77-35) Avail: NTIS HC A05/MF A01 ZLDI, Munich DM 16.80

The plans by Hermann Honnef for using wind power by means of large-scale wind energy conversion systems with regard to the proposed technical design and their presently expected cost-effectiveness were assessed. The conclusion that the findings and experience of the past few decades have shown that this type of wind energy conversion systems using contra-rotating, multi-blade turbines are not economical. The cost-effectiveness of this type was compared unfavourably with the advanced type of free-running, two-bladed turbines. The assertion that wind conditions at altitudes between 200 and 500 m were sufficiently explored for the purpose of wind energy facilities, is not valid. S.E.S.

**N79-18457#** Brown, Boveri und Cie. A.G., Heidelberg (West Germany). Zentrales Forschungslab.

**SOLAR WATER HEATING Final Report**

Hermann Birnbreier, Juergen Broschk, Bernd Dietrich, Rudolf Gehrer, Peter Goericke, Uwe Heidtmann, Wolfgang Kimpfenhaus, Karl Liemert, Gerhard Riebold, Karl Sueser et al. Dec. 1977 101 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Forsch. u. Technol. Prepared jointly with Suddeut. Metallwerke GmbH and Rheinisch Westfael. Electrizitätswerke AG (BMFT-FB-T-77-42) Avail: NTIS HC A06/MF A01 ZLDI, Munich DM 21.20

Tap water heating with conventional oil heating plants is performed with very low efficiency in summertime (5-20%). The object of this project was to evaluate if, in this season, solar energy can be used in middle Europe for water heating. Investigations were made on the stationary and daily efficiency of solar collectors alone as well as on complete solar systems at different places. The results show that about 50 to 90% of the heat requirement can be gained from solar energy, depending on the size of the collector area and water consumption. Due to unsteady weather conditions a supplementary electric heater is needed in the summer as well. The average annual useful heat gain per square meter area is about 1 kWh per day. G.Y.

**N79-18460#** Bundesministerium fuer Wissenschaft und Forschung, Vienna (Austria).

**AUSTRIAN 10KWE SOLAR POWER PLANT. A PROJECT OF THE FEDERAL MINISTRY FOR SCIENCE AND RESEARCH**

Federal Press Serv. 1977 28 p  
 Avail: NTIS HC A03/MF A01

Concepts under development in other nations were surveyed to clarify available options in the design and construction of a small solar energy plant suitable for use in developing countries. The possibility of marketing an Austrian-made power plant capable of operating without an human service was assessed as well as the possibility of supplying single components to users. Aspects of the design under consideration discussed include collector

circuits, freon circuits, prime movers, generator and electric networks, plant performance, and thermal storage. A.R.H.

**N79-18461#** Austrian Solar and Space Agency, Vienna.  
**PROPOSAL FOR A REPRESENTATION OF THE QUASI-STADY-STATE PERFORMANCE OF FLAT-PLATE COLLECTORS**

H. Koch (Univ. of Technol., Vienna) and M. Bruck Dec. 1977 17 p refs (ASSA-SE-B21/77) Avail: NTIS HC A02/MF A01

For reasons of simplicity and clearness the calculations and reflections of this proposal are confined to flat-plate collectors with a liquid heat transfer fluid with or without glass cover. Most of the well-known proposals represent the so-called efficiency of a collector (i.e. the ratio of insulation to useful heat extracted) virtually as a function of the difference between mean collector temperature and ambient air temperature. Errors of accuracy occur with this method the higher the average collector temperature is chosen. In this proposal, low temperature collectors (i.e. collectors without thermal insulation operated in combination with heat pumps within the range of ambient air temperature) are considered. The proposal, therefore, attempts to plot the efficiency of a collector which largely avoids certain disadvantages and inaccuracies of high temperature collectors. G.Y.

**N79-18462#** Woodard-Clyde Consultants, San Francisco, Calif.  
**IMPACT PREDICTION MANUAL FOR GEOTHERMAL DEVELOPMENT**

Jun. 1978 163 p refs (Contract DI-14-16-0008-2132) (PB-288128/2; FWS/OBS-78/77; LC-78-600108) Avail: NTIS HC A08/MF A01 CSCL 10A

Techniques for predicting probable effects of geothermal development on fish and wildlife resources in the Western United States are described. Appendices include an annotated bibliography; an example of a data collection program; a listing of endangered, threatened, and protected flora and fauna; and a supplement to erosion analysis techniques outlined in the manual. GRA

**N79-18463#** Illinois Univ., Urbana-Champaign. Water Resources Center.

**RESOURCE ANALYSIS: WATER AND ENERGY AS LINKED RESOURCES Final Report**

Margaret Lounsbury, Sanore Hebenstreit, and R. Stephen Berry Aug. 1978 210 p refs Prepared in cooperation with Chicago Univ., Ill. (Contract DI-14-31-0001-7030; OWRT Proj. A-081-ILL) (PB-288046/6; UIU-WRC-78-0134; W79-00453; OWRT-A-081-ILL(1); RR-134) Avail: NTIS HC A10/MF A01 CSCL 10A

An evaluation is made of the energy required to supply and treat water, rather than the water requirements of energy production. The primary energy requirements for three sectors of water management--municipal water supply, municipal sewage treatment, and water for irrigation--are evaluated. Six major cities, Chicago, Denver, Los Angeles, New Orleans, San Antonio, and St. Louis, are used as indicators of the national trend in energy requirements to supply water to municipalities. Nationwide data provided by the federal Environmental Protection Agency for 1977 and 1990 are used to determine the rate of change of energy required to treat municipal sewage over this period. The energy required to supply water for irrigation is estimated for three regions in the Southwest: Kern County, California; the Texas high plains; and San Carlos, Arizona. GRA

**N79-18464#** Environmental Protection Agency, Washington, D. C. Office of Energy, Minerals and Industry.

**PUBLIC HEARING TRANSCRIPT: FEDERAL NON-NUCLEAR ENERGY RESEARCH AND DEVELOPMENT PROGRAM**

Steve Plotkin and Jim Stemmle Jul. 1978 477 p refs (PB-287910/4; EPA-600/9-78-023) Avail: NTIS HC A21/MF A01 CSCL 10A

The proceedings of three days of public hearings on the Federal Nonnuclear Energy Research and Development Program

N79-18465

are presented. Future energy patterns and levels of coal use, solar energy and conservation, and oil shale and synthetic fuels from coal are among the topics discussed. GRA

N79-18465# National Technical Information Service, Springfield, Va.

**OPTICAL COATINGS FOR SOLAR CELLS AND SOLAR COLLECTORS. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1964 - Oct. 1978**

Brian Carrigan Dec. 1978 248 p Supersedes NTIS/PS-77/1036; NTIS/PS-76/0855; NTIS/PS-75/692; NTIS/PS-75/137 2 Vol. (NTIS/PS-78/1341/3; NTIS/PS-77/1036; NTIS/PS-76/0855; NTIS/PS-75/692; NTIS/PS-75/137) Avail: NTIS HC \$28.00/MF \$28.00 CSCL 10A

Materials and research for the development of selective coatings for solar energy conversion devices are described in these citations. These materials include types of coatings or covers used to reflect or transmit solar radiation in order to optimize solar conversion to heat or electricity. Most studies concern anti-reflection, thermal control, or reflective coatings. Coatings which act as optical filters are also covered. This updated bibliography contains 241 abstracts, 41 of which are new entries to the previous edition. GRA

N79-18466# National Technical Information Service, Springfield, Va.

**OPTICAL COATINGS FOR SOLAR CELLS AND SOLAR COLLECTORS. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1970 - Dec. 1978**

Brian Carrigan Dec. 1978 175 p 2 Vol. (NTIS/PS-78/1342/1) Avail: NTIS HC \$28.00/MF \$28.00 CSCL 10A

This bibliography of worldwide journal literature cites 169 reports on materials and research for the development of selective coatings for solar energy conversion devices. These materials include types of coatings or covers used to reflect or transmit solar radiation in order to optimize solar conversion to heat or electricity. Most studies concern anti-reflection, thermal control, or reflective coatings. Coatings which act as optical filters are also covered. GRA

N79-18487# TRW, Inc., Redondo Beach, Calif. Environmental Engineering Div.

**ENVIRONMENTAL ASSESSMENT DATA BASE FOR HIGH-BTU GASIFICATION TECHNOLOGY. VOLUME 1: TECHNICAL DISCUSSION Final Report, Jun. 1977 - Aug. 1978**

M. Ghassemi, K. Crawford, and S. Quinlivan Sep. 1978 172 p refs 3 Vol. (Contract EPA-68-02-2635) (PB-288602/6; EPA-600/7-78-186A) Avail: NTIS HC A08/MF A01; also available in set of 3 reports HC E13 as PB-288601-SET CSCL 07A

The existing data base for the EA of treated effluent of this quality is acceptable for discharge under the San Leandro Municipal Discharge Limitations with the exception of the phenolic compound and total cyanide loadings is analyzed and summarized. Surcharges would be imposed, however, based on the suspended solids and BOD loadings. If significant levels of phenolic compounds and cyanide are not present in a particular plant's wastewater discharge, ultrafiltration is judged capable of meeting local Municipal Discharge Standards. When phenolic compounds and cyanide are present at significant levels either ozonation or reverse osmosis are considered the preferred post-treatment processes. None of the treatment system options investigated is considered capable of reducing adhesives and sealants manufacturing plant wastewater BOD and COD loadings to the recommended Effluent Limitations Guidelines. GRA

N79-18488# TRW, Inc., Redondo Beach, Calif. Environmental Engineering Div.

**ENVIRONMENTAL ASSESSMENT DATA BASE FOR HIGH-BTU GASIFICATION TECHNOLOGY. VOLUME 2: APPENDICES A, B, AND C Final Report, Jun. 1977 - Aug. 1978**

M. Ghassemi, K. Crawford, and S. Quinlivan Sep. 1978 415 p refs 3 Vol. (Contract EPA-68-02-2635)

(PB-288603/4; EPA-600/7-78-186B) Avail: NTIS HC A18/MF A01; also Available in set of 3 reports HC E13 as PB288601-SET CSCL 07A

The existing data base for the EA of technology is reported and limitations of available data are identified. Results of the data base analysis indicate that there currently are insufficient data for comprehensive EA. The data are limited since: (1) there are no integrated plants, (2) some of the pilot plant data are not applicable to commercial operations, (3) available pilot plant data are generally not very comprehensive in that not all streams and constituents/parameters of environmental interest are addressed, (4) there is a lack of experience with control processes/equipment in high-Btu gasification service, and (5) toxicological and ecological implications of constituents in high-Btu gasification waste streams are not established. GRA

N79-18489# TRW, Inc., Redondo Beach, Calif. Environmental Engineering Div.

**ENVIRONMENTAL ASSESSMENT DATA BASE FOR HIGH-BTU GASIFICATION TECHNOLOGY. VOLUME 3: APPENDICES D, E, AND F Final Report, Jun. 1977 - Aug. 1978**

M. Ghassemi, K. Crawford, and S. Quinlivan Sep. 1978 342 p refs 3 Vol. (Contract EPA-68-02-2635)

(PB-288604/2; EPA-600/7-78-186C) Avail: NTIS HC A15/MF A01; also available in set of 3 reports HC E13 as PB-288601-SET CSCL 07A

The existing data base for the EA of technology is reported and limitations of available data are identified. Results of the data base analysis indicate that there currently are insufficient data for comprehensive EA. A number of programs are currently under way or planned which should generate some of the needed data. GRA

N79-18497# Kerr (Robert S.) Environmental Research Lab., Ada, Okla.

**TREATMENT OF PETROLEUM REFINERY, PETROCHEMICAL AND COMBINED INDUSTRIAL-MUNICIPAL WASTE-WATERS WITH ACTIVATED CARBON: LITERATURE REVIEW**

John E. Matthews Sep. 1978 98 p refs (PB-288211/6; EPA-600/2-78-200) Avail: NTIS HC A05/MF A01 CSCL 13B

A review of the literature on activated carbon adsorption as a treatment concept for petroleum refinery, petrochemical plant, and combined industrial-municipal wastewaters is presented in this report. A total of 241 references are cited. These references cover the various aspects of carbon adsorption and its application in the treatment of industrial and municipal wastewaters. GRA

N79-18535 Northwestern Univ., Evanston, Ill.  
**STOCHASTIC ANALYSIS OF WIND CHARACTERISTICS FOR ENERGY CONVERSION Ph.D. Thesis**

Arden Burdet Sigr. 1978 134 p Avail: Univ. Microfilms Order No. 7903363

Persistence and correlation analyses are carried out on 19 digital velocity records ranging in length from 4 to 24 years. Of these 19 records, 17 were obtained from the National Climatic Center and 2 from Argonne National Laboratory. These records are analyzed by season using random data analysis procedures to develop mathematical models that aid in assessing the wind potential of proposed wind energy conversion system (WECS) sites. From the analysis of the cross-correlation results it is feasible to employ statistics at a site for which long term records are available to assess the representativeness of the short term record monitored at the WECS site. When applying this approach, judgement must be used in a region which has significant topographical features which affect the flow of air over the region. Dissert. Abstr.

N79-18758# Technische Hogeschool, Eindhoven (Netherlands). Group Direct Energy Conversion.

**EXPERIMENTAL INVESTIGATION ON THE DISCHARGE STRUCTURE IN A NOBLE GAS MHD GENERATOR**

C. A. Borghi, A. F. C. Sens, A. Veefkind, and L. H. T. Rietjens  
Jan. 1978 22 p refs Sponsored partly by Bologna Univ. and  
partly by CNR  
(TH-78-E-79; ISBN-90-6144-079-3) Avail: NTIS  
HC A02/MF A01

An experimental investigation of the discharge structure in a noble gas MHD plasma has been performed, employing streak photography and other optical diagnostics. The discharge appeared to be concentrated in streamers. It was observed that the streamer structure of the discharge is very pronounced at stagnation temperatures around 2000 K, where the conductivity of the plasma becomes critical. Moreover, the observations indicate the presence of friction forces which result in a velocity of the streamers being always close to the velocity of the gas flow. The observations suggest that streamers are generated by break down phenomena at the inlet of the generator and subsequently convected downstream the channel. The structure of the discharge in the direction perpendicular to the electrode walls was analyzed by taking streak pictures with the slit in this direction in order to obtain information about the angle of propagation of the streamers.

Author

**N79-18810** Committee on Science and Technology (U. S. House).  
**ELECTRIC AND HYBRID VEHICLE ACT, PUBLIC LAW 94-413 DEMONSTRATION PROGRAM OBJECTIVE AND SCHEDULE**

Washington GPO 1978 428 p refs Hearing before the Subcomm. on Advanced Energy Technologies and Energy Conservation Res., Development and Demonstration of the Comm. on Sci. and Technol., 95th Congr., 1st Sess., No. 41, 12 Jul. 1977

(GPO-98-809) Avail: Subcomm. on Advanced Energy Technologies and Energy Conservation Res., Development and Demonstration

The status of implementation of an act authorizing the research, development, and demonstration of electric and hybrid electric vehicles is assessed. Opportunities and risks associated with various implementation strategies available to ERDA are identified and analyzed with respect to their potential for achieving expressed goals. The motivating policies are long-term petroleum savings, urban environment relief, and development of a competitive U.S. electric and hybrid vehicle industry. Topics discussed include energy storage systems, technology transfer, financial incentives, vehicle demonstration, vehicle service and other infrastructure requirements, safety considerations and requirements, and major factors influencing industry development.

A.R.H.

**N79-18815\*** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**BALTIMORE APPLICATIONS PROJECT Annual Progress Report Jun. 1977 - May 1978**

Thomas S. Golden and Philip Yaffee Jun. 1978 18 p  
(NASA-TM-79667: APR-4) Avail: NTIS HC A02/MF A01 CSCL 05A

The Baltimore Applications Project (BAP) was originally designed as an experimental effort to assist the government of the City of Baltimore in applying technology to the solution of municipal problems. Recent modifications in the structuring and operation of the program are discussed. A tabular update on the individual tasks undertaken and their treatment is provided. Details of energy and nonenergy related tasks are presented in appendices.

J.M.S.

**N79-18817#** Department of Energy, Washington, D. C. Transportation Energy Conservation Div.

**CHARACTERIZATION STUDY OF AN ELECTRIC MOTOR-TRANSMISSION SYSTEM FOR ELECTRIC VEHICLES**

Mar. 1978 108 p refs  
(Contract EY-76-C-02-2835)  
(HCP/M-2835/01) Avail: NTIS HC A06/MF A01

A unique electric transmission concept, consisting of two DC traction motors in tandem, for use in automotive vehicles is described. The device does away with the requirement of intermittent current supply at low speeds, and is shown to be

superior to conventional electric motor drives with regard to efficiency, flexibility of torque-speed requirements, control, and adaptability to regenerative braking. The electric motor-transmission can operate in either the differential, single-motor, or additive mode, producing both forward and reverse speeds while covering the entire spectrum of torque, speed, and power required by an automotive vehicle. A detailed study of a 7.5 Kw model was performed, providing performance data, current drain, output, efficiencies, and other relevant system characteristics. Based on this data, a preliminary design is formulated including estimates of size, weight, and cost. A catalog of specifications for power ratings ranging from 3.7 Kw to 15 Kw is included, so that the automotive designer may select a unit most appropriate to his vehicle.

L.S.

**N79-18834#** Water Purification Associates, Cambridge, Mass.  
**WATER-RELATED ENVIRONMENTAL EFFECTS IN FUEL CONVERSION, VOLUME 1. SUMMARY Final Report, Oct. 1978 - Sep. 1978**

Harris Gold and David J. Goldstein Oct. 1978 247 p  
(Contract EPA-68-03-2207; DOE-EX-76-C-01-2445)  
(PB-288313/0; EPA-600/7-78-197A) Avail: NTIS  
HC A11/MF A01 CSCL 07A

Results of an examination of water-related effects that can be expected from siting conversion plants in the major U.S. coal and oil shale bearing regions are presented. Ninety plant-site combinations were studied: 48 in the Central and Eastern U.S. and 42 in the Western. Synthetic fuel technologies examined include: coal gasification to convert coal to pipeline gas; coal liquefaction to convert coal to low sulfur fuel oil; coal refining to produce a de-ashed, low-sulfur solvent refined (clean) coal; and oil shale retorting to produce synthetic crude. Results presented include the range of water requirements, conditions for narrowing the range and optimizing the use of water, ranges of residual solid wastes, and cost and energy requirements for waste water treatment.

J.M.S.

**N79-18969#** Dynamics Research Corp., Wilmington, Mass. Systems Div.

**AN ANALYSIS OF FUEL CONSERVING OPERATIONAL PROCEDURES AND DESIGN MODIFICATIONS FOR BOMBER/TRANSPORT AIRCRAFT. VOLUME 1: EXECUTIVE SUMMARY Final Report, 7 Jun. 1978 - 7 Jul. 1978**

R. Aggarwal Jul. 1978 24 p refs  
(Contract F33615-78-C-3104)  
(AD-A061746; R-247U-Vol-1; AFFDL-TR-78-96-Vol-1) Avail:  
NTIS HC A02/MF A01 CSCL 01/3

Various proposed improvements in the design and operational procedures for bomber/transport aircraft are evaluated. The evaluation is performed in terms of the estimated savings in fuel consumption and in Direct Operating Cost (DOC). As an aid in the evaluation of design modifications, graphs of fuel and DOC savings as a function of the design parameters are developed. These graphs are based on actual mission trajectory data rather than some type trajectory profile. The actual mission data is presented in terms of histograms which provide statistical information concerning altitude, air speed, take-off weight, landing weights, and mission time. Separate analyses are performed on the following aircraft: the B-52G, the B-52H, the KC-135, the C-141, the C-130, and the C-5A.

Author (GRA)

**N79-19069#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
**THE UPDATED ALGORITHM OF THE ENERGY CONSUMPTION PROGRAM (ECP): A COMPUTER MODEL SIMULATING HEATING AND COOLING ENERGY LOADS IN BUILDINGS**

F. L. Lansing, D. M. Strain, V. W. Chai, and S. Higgins In its  
The Deep Space Network 15 Feb. 1979 p 107-115

Avail: NTIS HC A09/MF A01 CSCL 10B

The energy Consumption Computer Program was developed to simulate building heating and cooling loads and compute thermal and electric energy consumption and cost. This article reports on the new additional algorithms and modifications made in an effort to widen the areas of application. The program

## N79-19060

structure was rewritten accordingly to refine and advance the building model and to further reduce the processing time and cost. The program is noted for its very low cost and ease of use compared to other available codes. The accuracy of computations is not sacrificed however, since the results are expected to lie within + or - 10% of actual energy meter readings.

Author

### N79-19060\*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. A TWO-DIMENSIONAL THERMAL ANALYSIS OF A NEW HIGH-PERFORMANCE TUBULAR SOLAR COLLECTOR

F. L. Lansing and C. S. Yung In its The Deep Space Network  
15 Feb. 1979 p 116-131 refs

Avail: NTIS HC A09/MF A01 CSCL 10A

The first of two articles are presented which describe and analyze the thermal performance of a vacuum tube solar collector. The assumptions and mathematical modeling are presented. The problem is reduced to the formulation of two simultaneous linear differential equations characterizing the collector thermal behavior. After applying the boundary conditions, a general solution is obtained which is found similar to the general Hottel, Whillier and Bliss form but with a complex flow factor.

L.S.

### N79-19071\*# Rockwell International Corp., Downey, Calif. Satellite Systems Div.

#### SATELLITE POWER SYSTEM (SPS) CONCEPT DEFINITION STUDY (EXHIBIT C) Final Review

G. M. Haley 21 Mar. 1979 477 p refs  
(Contract NAS8-32475)

(NASA-CR-161173; SSD-79-0076) Avail: NTIS

HC A21/MF A01 CSCL 22B

The major outputs of the study are the constructability studies which resulted in the definition of the concepts for satellite, rectenna, and satellite construction base construction. Transportation analyses resulted in definition of heavy-lift launch vehicle, electric orbit transfer vehicle, personnel orbit transfer vehicle, and intra-orbit transfer vehicle as well as overall operations related to transportation systems. The experiment/verification program definition resulted in the definition of elements for the Ground-Based Experimental Research and Key Technology plans. These studies also resulted in conceptual approaches for early space technology verification. The cost analysis defined the overall program and cost data for all program elements and phases.

G.Y.

### N79-19169 Oklahoma State Univ., Stillwater. CATALYST AGING TESTS AND THE ROLE OF CATALYST WETTING ON HYDRODESULFURIZATION OF A COAL DERIVED LIQUID Ph.D. Thesis

Dhirendra Chhotal Mehta 1978 253 p  
Avail: Univ. Microfilms Order No. 7903708

A trickle bed reactor was selected to study the hydrodesulfurization of raw anthracene oil, a coal derived oil, over various commercially available Co-Mo-Alumina catalysts. The experimental equipment was designed for operating conditions ranging from ambient to 850 F (455 C) and 1,800 psig pressure. The hydrodesulfurization studies were conducted at reactor temperatures of 600,650,700 and 750 F (314,343,371 and 399 C), at pressure of 500,1,000 and 1,500 psig and at liquid volume hourly space times ranging from 0.325 to 1.480 hours. The hydrotreating catalysts were also tested for their aging characteristics during 200-hour runs at steady reactor conditions of 700 F (371 C), 1,000 psig and 0.44 liquid weight hourly space time. Constant amounts of catalyst, 20 grams, were used for all the experimental runs. Various kinetic models were tested for their relative fit to the results of the study.

Dissert. Abstr.

### N79-19171# Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Energy Systems Div.

#### METHANE UTILIZATION FROM COALBEDS FOR POWER GENERATION Quarterly Technical Progress Report, 1 Dec. 1977 - 1 Apr. 1978

1 Apr. 1978 12 p

(Contract EY-77-C-21-8098)

(TID-28408) Avail: NTIS HC A02/MF A01

Technical progress is reported in engineering a system to demonstrate the economic utilization of mine gas (a diluted mixture of methane and air) as a fuel for gas turbine/electrical generator conversion of mine gas to electrical energy. Aspects reviewed include modification of the Saturn engine to use gaseous fuel, design of skid mounted interface equipment, the use of existing gob degasification boreholes as a fuel source, fuel analysis, safety review, electrical power interface, environmental impact, economic analysis, and fuel reservoir characteristics.

A.R.H.

### N79-19173# TRW Systems, Redondo Beach, Calif.

#### APPLICABILITY OF PETROLEUM REFINERY CONTROL TECHNOLOGIES TO COAL CONVERSION Final Report, Jul. 1977 - Aug. 1978

M. Ghassemi, D. Strehier, K. Crawford, and S. Quinlivan Oct. 1978 127 p refs  
(Contract EPA-68-02-2635)  
(PB-288630/7; EPA-600/7-78-190) Avail: NTIS  
HC A07/MF A01 CSCL 07A

This is part of a comprehensive program for the environmental assessment of high-Btu gasification technology. Process/waste streams from coal gasification and liquefaction processes were characterized. Streams with refinery counterparts were identified. Toxicological and health effects data were also collected on waste stream constituents. Control technologies used in refineries to manage the identified streams were evaluated and their applicability to counterpart coal conversion streams was assessed. Study results indicate that, despite similarities between the refinery process/waste streams and their coal conversion counterparts, significant composition differences between the analogous streams would affect applicability and design of a control technology.

GRA

### N79-19186\* National Aeronautics and Space Administration, Pasadena Office, Calif.

#### ELECTROMAGNETIC RADIATION ENERGY ARRANGEMENT Patent

Robert R. Lipkis (Thompson, Ramo Wooldridge, Inc., Cleveland) and John E. Vehrencamp, inventors (to NASA) (Thompson Ramo Wooldridge, Inc., Cleveland) Issued 16 Mar. 1965 4 p Filed 26 May 1961 Sponsored by NASA

(NASA-Case-WOO-00428-1; US-Patent-3,173,801;  
US-Patent-Appl-SN-112999; US-Patent-Class-117-35) Avail:  
US Patent and Trademark Office CSCL 20N

A solar energy collector and infrared energy reflector is described which comprises a vacuum deposited layer of aluminum of approximately 200 to 400 Angstroms thick on one side of a substrate. An adherent layer of titanium with a thickness of between 800 and 1000 Angstroms is vacuum deposited on the aluminum substrate and is substantially opaque to solar energy and substantially transparent to infrared energy.

Official Gazette of the U.S. Patent and Trademark Office

### N79-19305# Air Force Academy, Colo.

#### THE DEVELOPMENT OF A LASER DOPPLER VELOCIMETRY SYSTEM FOR UNSTEADY SEPARATED FLOW RESEARCH: PRELIMINARY RESULTS Interim Report, Sep. 1977 - Sep. 1978

R. A. Kadlec, G. W. Sparks, Jr., and Michael S. Francis Oct. 1978 28 p refs  
(AF Proj. 2307)  
(AD-A061724; FJSRL-TR-78-0010) Avail: NTIS  
HC A03/MF A01 CSCL 20/4

Each of the six case studies documents public participation in Federal and/or state governmental decisions related to energy facility siting. Four of the cases involved decisions on specific facilities at specific sites, namely: (1) various state and federal licensing procedures for the Seabrook, New Hampshire nuclear facility; (2) the Maine Environmental Improvement Commission's denial of a permit for an oil refinery on Sears Island in Penobscot Bay; (3) the Atomic Energy Commission's amendment to the license for the Big Rock Point, Michigan nuclear reactor to allow an increased level of plutonium-enriched fuel use; (4) the

AEC's review, arising from disclosure of a geological fault, of the North Anna River, Virginia, nuclear facility. A fifth case documents a series of public meetings conducted in Pennsylvania by the Governor's Energy Council to consider the energy park concept. The sixth study was a narrative history and analysis of RM-50-1, a rulemaking proceeding conducted by the AEC in 1972 and 73 on emergency core cooling system operating standards. GRA

**N79-19429#** Monsanto Research Corp., Dayton, Ohio.  
**SOURCE ASSESSMENT: OPEN MINING OF COAL STATE OF THE ART** Final Report, Sep. 1974 - Sep. 1977  
 S. J. Rusek, S. R. Archer, R. A. Wachter, and T. R. Blackwood  
 Sep. 1978 90 p refs  
 (Contract EPA-68-02-1874)  
 (PB-288497/1; MRC-DA-709; EPA-600/2-78-004X) Avail:  
 NTIS HC A05/MF A01 CSCL 13B

Atmospheric emissions from the open mining of coal were studied. The potential environmental effect of this emission source is evaluated using source severity, defined as the ratio of the maximum ground-level concentration of a pollutant at a representative plant boundary to a hazard factor. The hazard factor is the ambient air quality standard for criteria pollutants and an adjusted threshold limit value for other pollutants. Respirable dusts are generated from five unit operations and from wind erosion. GRA

**N79-19439** Johns Hopkins Univ., Baltimore, Md.  
**SOLAR HEATING OF BUILDINGS: DESIGN OPTIMIZATION AND ECONOMIC ANALYSIS** Ph.D. Thesis  
 Arthur Edwin McGarity 1979 163 p  
 Avail: Univ. Microfilms Order No. 7906470

The problem of the design and economic analysis of solar heated buildings is treated as a multivariable optimization problem involving collector area, storage volume, and heating load reduction as decision variables. A mathematical programming optimization model employing a hybrid basic descent method is developed and is used to generate optimal area-volume paths which describe the cost minimizing combinations of collector area and storage volume for solar space heating systems which provide various fractions of the heating load (solar fractions). Dissert. Abstr.

**N79-19440** Stanford Univ., Calif.  
**ALTERNATIVE MODELS OF ENERGY DEMAND**  
 Ph.D. Thesis  
 Sergio Granville 1978 169 p  
 Avail: Univ. Microfilms Order No. 7905870

The relationship between three aggregate inputs to the U.S. economy: value added by capital and labor, electric energy, and nonelectric energy was studied. The analysis consisted of an attempt to obtain improved econometric estimates of two demand elasticity parameters: the elasticity of substitution between energy and value added and the elasticity of substitution between electric and nonelectric energy. The short-run forecasting performance and the energy policy implications of the three alternative sets of demand elasticity parameters were examined. Dissert. Abstr.

**N79-19442** Massachusetts Univ., Amherst.  
**ENERGY ANALYSES APPLIED TO OCEAN THERMAL ENERGY CONVERSION AND AN OFFSHORE WIND POWER SYSTEM** Ph.D. Thesis  
 Tage Carl Gerald Carlson 1978 167 p  
 Avail: Univ. Microfilms Order No. 7901982

The primary concern for the dwindling fossil energy supplies in this country has led to an increased use of energy analyses and large scale energy modeling as a major input to energy policy decisions. Currently the more prominent energy analyses used are: net energy analysis, dynamic energy analysis, input-output matrix analysis, and second law of thermodynamics analysis. In addition, four large scale energy models were also generated. Each of the modes and analyses are explained and examined with a comparison and critique given on each. It is concluded that at the present time, no single energy analysis technique or model will provide all the necessary information on which an energy policy decision can be based. Dissert. Abstr.

**N79-19444** California Univ., Berkeley.  
**EVALUATION OF THE USE OF OXYGEN AS OXIDANT IN FOSSIL FUEL FIRED OPEN CYCLE MHD-STEAM ENERGY CONVERSION PROCESSES** Ph.D. Thesis  
 Habib Amin 1978 121 p

Avail: Univ. Microfilms Order No. 7904362

The thermodynamics and economics of using oxygen versus air as the oxidant in large coal-fired MHD-steam energy conversion plants were evaluated and compared. Coal burned with oxygen produces combustion gases of very high temperature and of relatively high electrical conductivity. As a result of the reduction in gas flow that is a consequence of combustion with oxygen, there are significant reductions in the sizes and costs of required preheaters, MHD ducts, and superconducting magnets. Furthermore, combustion with high purity oxygen minimizes air pollution problems related to the conversion of molecular nitrogen oxides. The reduction in SO<sub>2</sub> and particulates control costs as a result of the decrease in combustion gas flow rate is analyzed. The major disadvantage of coal combustion with oxygen is found to be the energy and capital cost required for the oxygen plant. Throughout the study, the advantages and disadvantages of using oxygen are evaluated and compared for selected power generation systems.

Dissert. Abstr.

**N79-19445** California Univ., Berkeley.  
**V-GROOVE MULTIJUNCTION SOLAR CELLS** Ph.D. Thesis  
 Terry Ivan Chappell 1978 130 p  
 Avail: Univ. Microfilms Order No. 7904404

A study of three components which can be used in a solar utilization system are described. The three components are: a photovoltaic converter, an intensity sensor, and selective thermal absorber. The results of extensive computer simulations, theoretical analyses, and measurements are reported for these components. A new family of silicon photovoltaic devices called V-Groove Multi-Junction (VGMJ) solar cells are described. The details of the fabrication for the Type 6 VGMJ solar cells is also described. The design of a silicon sensor intended for use in rapid-scan solar flux mapping at high illumination intensities is discussed. The characteristics of a water absorber in front of a silicon solar cell are quantified through the use of computer simulations and measurements.

Dissert. Abstr.

**N79-19446** Massachusetts Univ., Amherst.  
**TWO-DIMENSIONAL ANALYSIS OF VERTICAL AXIS WINDMILLS** Ph.D. Thesis  
 Edward S. VanDusen 1978 296 p  
 Avail: Univ. Microfilms Order No. 7903857

A two-dimensional inviscid flow model is developed for vertical axis windmills with two foils of arbitrary shape. The solution is in the reference frame of the rotating foils and includes a time developing wake as vorticity is shed from the trailing edge of each foil. The results from different time steps, hence rotor orientations, are presented as plots of torque, streamlines, and power coefficient over a wide range of tip speed ratios. A heuristic stall model to account for flow separation is included in a manner that anticipates future viscous analysis. Results investigating the time step between solutions and different geometries are presented and compared to empirical values.

Dissert. Abstr.

**N79-19447\*** National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.  
**SOLAR CELL MODULE ASSEMBLY JIG** Patent  
 Herbert W. OFarrell, inventor (to NASA) (TRW Inc., Redondo Beach, Calif.) Issued 26 Jul. 1966 8 p Filed 10 Jun. 1963 (NASA-Case-XGS-00829-1; US-Patent-3,262,694; US-Patent-App-SN-286824; US-Patent-Class-269-153) Avail: US Patent and Trademark Office CSCL 10A

The invention relates to the manufacture of solar cell modules and more particularly to a jig for assembling, positioning and maintaining the components under resilient pressure, while the entire assembly and the jig is subjected to heat for simultaneously soldering all of the various circuit connections; as well as structurally bonding the layers into a strong light weight structure which minimizes the tendency of the solar cells to crack and the other components and electrical connections to fracture.

Official Gazette of the U.S. Patent and Trademark Office

N79-19449

N79-19449# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
PRIMARY LITHIUM BATTERY TECHNOLOGY AND ITS  
APPLICATION TO NASA MISSIONS  
H. A. Frank 15 Feb. 1979 30 p refs  
(Contract NAS7-100)  
(NASA-CR-158229; JPL-Pub-79-6) Avail: NTIS  
HC A03/MF A01 CSCL 10C

A description is given of the components, overall cell reactions, and performance characteristics of promising new ambient temperature lithium primary systems based on the Li-V2O5, Li-SO2, and Li-SOC12 couples. Development status of these systems is described in regard to availability and uncertainties in the areas of safety and selected performance characteristics. Studies show that use of lithium batteries would enhance a variety of missions and applications by decreasing power systems weight and thereby increasing payload weight. In addition, the lithium batteries could enhance cost effectiveness of the missions. G.Y.

N79-19450# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
BIOCONVERSION STUDY CONDUCTED BY JPL  
John Kalvinskas 15 Nov. 1978 124 p refs  
(Contract NAS7-100)  
(NASA-CR-158228; JPL-Pub-79-9) Avail: NTIS  
HC A06/MF A01 CSCL 10A

The Jet Propulsion Laboratory (JPL) of Caltech conducted a study of bioconversion as a means of identifying the role of biomass for meeting the national energy fuel and chemical requirements and the role and means for JPL-Caltech involvement in bioconversion. The bioconversion study included the following categories: biomass sources, chemicals from biomass, thermochemical conversion of biomass to fuels, biological conversion of biomass to fuels and chemicals, and basic bioconversion sciences. A detailed review is included of the bioconversion fields cited with specific conclusions and recommendations given for future research and development and overall biomass system engineering and economic studies. Author

N79-19451# Technical Marketing Associates, Inc., Concord, Mass.  
MARKET DEFINITION STUDIES FOR PHOTOVOLTAIC  
HIGHWAY APPLICATIONS  
Dec. 1978 .121 p  
(Contracts DEN-3-40; DE-A101-79ET20485)  
(NASA-CR-159477; DOE/NASA/0040-78/1) Avail: NTIS  
HC A06/MF A01 CSCL 10A

Prospects for solar electric power in applications related to highways within the continental United States are examined. Principal prospective users are found to be the highway departments of the various states. Economic analysis is employed to demonstrate that suitable applications can occur when powering apparatus such as signs, crossing signals, or instruments which consume less than 100 watts on the average, provided they are located at least one-half mile from existing utility power. Such applications are projected to occur two or three times per state per year. Attitudes of highway officials toward possible use of solar power are sampled and described. Although falling photovoltaic cell prices are expected to have little effect on sales potential here, methods for federal stimulation of this market are discussed. G.Y.

N79-19453# Honeywell, Inc., Minneapolis, Minn.  
PRELIMINARY DESIGN PACKAGE FOR RESIDENTIAL  
HEATING/COOLING SYSTEM: RANKINE AIR CONDITIONER REDESIGN  
Dec. 1978 109 p Prepared for DOE  
(Contract NAS8-32093)  
(NASA-CR-150871) Avail: NTIS HC A06/MF A01 CSCL 10A

A summary of the preliminary redesign and development of a marketable single family heating and cooling system is presented. The interim design and schedule status of the residential (3-ton) redesign, problem areas and solutions, and the definition of plans for future design and development activities were discussed. The proposed system for a single-family residential heating and cooling system is a single-loop, solar-assisted, hydronic-to-warm-air heating subsystem with solar-assisted domestic water heating

and a Rankine-driven expansion air-conditioning subsystem. Author

N79-19454# Comstock and Wescott, Inc., Cambridge, Mass.  
DEVELOPMENT OF A PHASE-CHANGE THERMAL STORAGE  
SYSTEM USING MODIFIED ANHYDROUS SODIUM  
HYDROXIDE FOR SOLAR ELECTRIC POWER GENERATION  
Barry M. Cohen, Richard E. Rice, and Peter E. Rowny Dec. 1978 252 p refs Prepared for DOE  
(Contracts NAS3-20615; EC-77-A-31-1034)  
(NASA-CR-159465; DOE/NASA/0615-79/1) Avail: NTIS  
HC A12/MF A01 CSCL 10A

A thermal storage system for use in solar power electricity generation was investigated analytically and experimentally. The thermal storage medium is principally anhydrous NaOH with 8% NaNO3 and 0.2% MnO2. Heat is charged into storage at 584 K and discharged from storage at 582 K by Therminol-66. Physical and thermophysical properties of the storage medium were measured. A mathematical simulation and computer program describing the operation of the system were developed. A 1/10 scale model of a system capable of storing and delivering 3.1 x 10 to the 6th power kJ of heat was designed, built, and tested. Tests included steady state charging, discharging, idling, and charge-discharge conditions simulating a solar daily cycle. Experimental data and computer-predicted results are correlated. A reference design including cost estimates of the full-size system was developed. Author

N79-19455# Copper Development Association, Inc., New York, N. Y.  
FINAL SYSTEM INSTRUMENTATION DESIGN PACKAGE  
FOR DECADE 80 SOLAR HOUSE  
Dec. 1978 69 p refs  
(Contract NAS8-32244)  
(NASA-CR-150869) Avail: NTIS HC A04/MF A01 CSCL 10A

The final configuration of the Decade 80 solar house to monitor and collect system performance data is presented. A review demonstrated by actual operation that the system and the data acquisition subsystem operated satisfactorily and installation of instrumentation was in accordance with the design. This design package is made up of (1) site and system description, (2) operating and control modes, and (3) instrumentation program (including sensor schematic). M.M.M.

N79-19456# Solarex Corp., Rockville, Md.  
DEVELOPMENT OF AN IMPROVED HIGH EFFICIENCY THIN  
SILICON SOLAR CELL Quarterly Report  
C. Wrigley and G. Storti Jul. 1978 10 p  
(Contracts NAS7-100; JPL-954883)  
(NASA-CR-158172; SX/115/3Q; QR-3) Avail: NTIS  
HC A02/MF A01 CSCL 10A

Efforts were directed towards investigating means of producing more effective high-low junctions at the back of the cell. Cells with output power up to 77 mW (AMO efficiency of 14.2 percent) were fabricated. Some reflectivity studies were also made. Deliveries of 2 cm x 2 cm experimental cells included a number having AMO outputs greater than 70 mW. L.S.

N79-19459# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
THERMAL AND OTHER TESTS OF PHOTOVOLTAIC  
MODULES PERFORMED IN NATURAL SUNLIGHT  
J. W. Stultz 31 Jul. 1978 58 p refs Sponsored by NASA and DOE  
(NASA-CR-158174; JPL-5101-76; DOE/JPL-1012-78/9) Avail:  
NTIS HC A04/MF A01 CSCL 10A

The bulk of the testing was the characterization of twenty-nine modules according to their nominal operating cell temperature (NOCT) and the effect on NOCT of changes in module design, various residential roof mounting configurations, and dirt accumulation. Other tests, often performed parallel with the NOCT measurements, evaluated the improvement in electrical performance by cooling the modules with water and by channeling the waste heat into a phase change material (wax). Electrical degradation resulting from the natural marriage of photovoltaic and solar water heating modules was also demonstrated. Cost

effectiveness of each of these techniques are evaluated in light of the LSA cost goal of \$0.50 per watt. L.S.

**N79-19481#** Council on Environmental Quality, Washington, D.C.

### THE GOOD NEWS ABOUT ENERGY

1979 64 p refs

Avail: NTIS MF A01; SOD HC

A project was undertaken to investigate the potential for achieving lower energy growth in the United States and the implications of this low energy growth for the economy, the environment and government policy. The overall conclusion is that the United States can do well, indeed prosper, on much less energy than has been commonly supposed. The principal basis for this is the accumulating evidence that the means are available to wring far more consumer goods and services out of each unit of fuel that is used, whether it be a barrel of oil or a ton of coal or uranium. L.S.

**N79-19482#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. LSA LOW-COST SOLAR ARRAY PROJECT Quarterly Report,

Oct. - Dec. 1977

Dec. 1977 76 p Sponsored by NASA and DOE

(NASA-CR-158250; JPL-5101-81; QR-7;

DOE/JPL-1012-78/13; JPL-Pub-78-97) Avail: NTIS HC A05/MF A01 CSCL 10A

The activities of the Low-Cost Silicon Solar Array Project during the period October through December, 1977 are reported. The LSSA Project is assigned responsibility for advancing silicon solar array technology while encouraging industry to reduce the price of arrays to a level at which photovoltaic electric power systems will be competitive with more conventional power sources early in the next decade. Set forth are the goals and plans with which the Project intends to accomplish this and the progress that was made during the quarter. G.Y.

**N79-19487#** National Bureau of Standards, Washington, D. C. Center for Building Technology.

### GEOGRAPHICAL VARIATION IN THE HEATING AND COOLING REQUIREMENTS OF A TYPICAL SINGLE-FAMILY HOUSE, AND CORRELATION OF THESE REQUIREMENTS TO DEGREE DAYS

Edward A. Arens and William L. Carroll Nov. 1978 64 p refs Sponsored in part by HUD and Assistant Sec. for Policy Develop. and Res.

(Contract E(49-1)-3800)

(PB-289204/0; NBS-BSS-116) Avail: NTIS HC A04/MF A01 CSCL 10A

Test Reference Year (TRY) hourly climate data tapes are assessed to determine how well they represent long-term average climate when used for estimating average annual heating and cooling requirements. A method to adjust heating and cooling requirements is presented. The geographic variations of annual heating and cooling requirements across the U.S. are quantified by computing the heating and cooling requirements of a typical ranch-style residence for the 8760 hours of each of the 60 TRY tapes and the results are adjusted. The effectiveness of degree-day data for predicting these computed annual heating and cooling requirements is examined, and the variability of heating and cooling requirements within degree-day zones of 1000 degree-day width is presented. GRA

**N79-19488#** AIA Research Corp., Washington, D. C.

### PHASE ONE/BASE DATA FOR THE DEVELOPMENT OF ENERGY PERFORMANCE STANDARD FOR NEW BUILDINGS. TASK REPORT: BUILDING CLASSIFICATION

12 Jan. 1978 131 p

(Contract HUD-H-2689)

(PB-286904/8; HUD-0000194) Avail: NTIS HC A07/MF A01 CSCL 13A

Building classifications to aid in the derivation of energy performance standards for the construction of new buildings are presented. An effort was made to develop a system of building classifications appropriate to the collection of data on designed energy performance and the implementation of national energy performance standards under Title III of the Energy Conserva-

tion and Production Act. Two classification schemes are described: a general classification system encompassing all building types using energy for space conditioning, and an abbreviated classification system for data collection that includes only building types expected to contribute significantly to construction volume over the next 10 years. GRA

**N79-19489#** Nuclear Regulatory Commission, Washington, D. C. Cost-Benefit Analysis Branch.

### COAL AND NUCLEAR: A COMPARISON OF THE COST OF GENERATING BASELOAD ELECTRICITY BY REGION

Jack O. Roberts, Sarah M. Davis, and Darrel A. Nash Dec. 1978 113 p

(PB-289585/2; NUREG-0480) Avail: NTIS HC A06/MF A01 CSCL 10B

The results of an economic comparison by region of coal and nuclear fueled electric generating options that may be available to utilities during the late 1980's and early 1990's are reported. Some of the many factors that may be considered by public agencies and electric utilities in planning to meet future electric energy needs are discussed. The timeframe is for generating units now in the planning stages and units which are expected to enter the licensing phase over the next few years. These generating units would enter the operational phase in the late 1980's. GRA

**N79-19470#** Society of Petroleum Industry Biologists, Los Angeles, Calif.

### ENERGY/ENVIRONMENT 1978: SYMPOSIUM ON ENERGY DEVELOPMENT IMPACTS

June Lindstedt-Siva Aug. 1978 340 p Symp. held at Los Angeles, Calif., 22-24 Aug. 1978

(PB-288578/8; LC-78-110283) Avail: NTIS HC A15/MF A01 CSCL 13B

The Proceedings volume contains 27 papers on subjects such as the management and use of biological and archaeological baseline data; ecological impacts of energy development (coal mines, offshore oil, power plants, pipelines); energy development and public policy; oil spills; fate and effects and minimizing the environmental impacts of oil spills. GRA

**N79-19472#** General Accounting Office, Washington, D. C. Energy and Minerals Div.

### EVALUATION OF FOUR ENERGY CONSERVATION PROGRAMS--FISCAL YEAR 1977

21 Nov. 1978 90 p

(PB-288825/3; EMD-78-81) Avail: NTIS HC A05/MF A01 CSCL 10A

The report reviews four programs: Energy conservation and renewable-resource obligation guarantees, national energy conservation and renewable-resource demonstration for existing dwelling units, supplemental State energy conservation plans, and weatherization assistance for low-income persons. GRA

**N79-19488#** Environmental Protection Agency, Ann Arbor, Mich. Technical Assessment and Evaluation Branch.

### EFFECTS OF LOW AMBIENT TEMPERATURE ON THE EXHAUST EMISSIONS AND FUEL ECONOMY OF 84 AUTOMOBILES IN CHICAGO

Wayne Heinmiller Oct. 1978 25 p refs

(PB-288400/5) Avail: NTIS HC A02/MF A01 CSCL 13F

The results of a project are described in which pairs of tests were conducted in 84 in-use passenger cars, once under low temperature conditions (16 F to 57 F), and again under standard laboratory conditions. Each sequence included the 1975 Federal Test Procedure (exhaust emissions only), the Highway Fuel Economy Test and three short cycle tests. The vehicles were randomly obtained, tested in an as-received condition, and work was performed between January and March 1978. Results show that HC and CO are most sensitive to cold temperature, while NOX is affected only slightly. Fuel economy suffered by an average of 7% Vehicle fleets from manufacturers which used different control technologies were found to behave considerably differently at low temperatures. GRA

N79-19496

**N79-19496# Water Purification Associates, Cambridge, Mass.**  
**WATER-RELATED ENVIRONMENTAL EFFECTS IN FUEL CONVERSION. VOLUME 2: APPENDICES Final Report.**  
Oct. 1976 - Sep. 1978

David J. Goldstein Oct. 1978 666 p refs  
(Contract EPA-68-03-2207)  
(PB-288874/1; EPA-600/7-78-1978-Vol-2) Avail: NTIS HC A99/MF A01 CSCL 07A

Results of an examination of water-related effects that can be expected from siting conversion plants in the major U.S. coal and oil shale bearing regions are reported. Ninety plant-site combinations were studied: 48 in the Central and Eastern U.S. and 42 in the Western. Synthetic fuel technologies examined include: coal gasification to convert coal to pipeline gas; coal liquefaction to convert coal to low sulfur fuel oil; coal refining to produce a de-ashed, low-sulfur solvent refined (clean) coal; and oil shale retorting to produce synthetic crude. The range of water requirements, conditions for narrowing the range and optimizing the use of water, ranges of residual solid wastes, and cost and energy requirements for wastewater treatment are presented. GRA

**N79-19506 California Univ., Berkeley.**  
**SEISMOLOGICAL INVESTIGATIONS IN GEOTHERMAL REGIONS Ph.D. Thesis**

Ernest Luther Major 1978 232 p  
Avail: Univ. Microfilms Order No. 7904540

Seismological methods, including studies of microearthquakes, P- and S-wave velocities and P-wave attenuation were investigated as tools for the exploration and delineation of geothermal resources. Seismograms from explosions and microearthquakes were examined for changes in frequency content and relative arrival times across a known geothermal area, The Geysers, California and a potential geothermal region, Grass Valley, Nevada. Microearthquakes within the two regions were examined for evidence of spatial variations in radiated P- and S-waves. Additional information concerning basin and range structure was provided by regional refraction studies. Detailed structural analysis in Grass Valley was obtained by commercial reflection and refraction work. Heat flow modeling, consistent with structure inferred by seismological techniques, was used to discriminate between conductive and convective heat flow anomalies in Grass Valley. Dissert. Abstr.

**N79-19521# National Aeronautics and Space Administration, Pasadena Office, Calif.**  
**BOREHOLE GEOLOGICAL ASSESSMENT Patent Application**

William Spuck, III, inventor (to NASA) (JPL) Filed 4 May 1978 19 p Sponsored by NASA  
(NASA-Case-NPO-14231-1; US-Patent-Appl-SN-903019) Avail: NTIS HC A02/MF A01 CSCL 08G

A method and apparatus are provided for performing geological assessments of a formation located along a borehole, which includes a boring tool that bores a pair of holes into the walls of the borehole and into the surrounding strata, and a pair of probes installed in the holes. One of the probes applies an input such as a current or pressured fluid, and the other probe senses a corresponding input which it receives from the strata. The boring tool can include a series of rigid bore segments that can be easily installed in a housing that lies in the borehole, and apparatus for connecting the bore segments in series while also advancing them into the strata surrounding the borehole, so that a straight hole can be bored in the strata. NASA

**N79-19563# Oregon State Univ., Corvallis. Sea Grant Coll. Program.**

**GEOThermal RESOURCES FOR AQUACULTURE**  
Sep. 1978 51 p Workshop held in Boise, Idaho, 13-15 Dec. 1977 Sponsored by NOAA  
(PB-290345/8; ORESU-W-78-001; NOAA-78102401) Avail: NTIS HC A04/MF A01 CSCL 08G

The workshop sought consensus on the potential of geothermal aquaculture for commercial success. Geothermal sites in

the United States Pacific Northwest may represent useful locations for commercial freshwater aquaculture. Awareness of this opportunity stems from the research observation that warmed water increases growth rates of certain species of fish and shellfish, and from the fact that some of these geothermal sites have already been tapped for electric power generation and other uses. Questions addressed included: what species can or should be produced; what biological constraints exist through nutrition, disease, or husbandry, and what engineering, economic, marketing, or institutional and legal problems must be solved. Research, training, and advisory needs were identified and priorities described. GRA

**N79-19568# Battelle Pacific Northwest Labs., Richland, Wash.**  
**WIND CHARACTERISTICS PROGRAM ELEMENT Annual Report Jul. 1977 - Jul. 1978**  
L. L. Wendell, J. R. Connell, W. T. Pennell, D. S. Renne, and H. L. Wegley Dec. 1978 130 p refs  
(Contract EY-76-C-06-1830)  
(PNL-2545; UC-60) Avail: NTIS HC A07/MF A01

This annual report to the wind systems branch of the Department of Energy's (DOE's) Division of Distributed Solar Technology describes the technical progress within each program area from July 1977 through July 1978. The progress is presented which was accomplished directly by PNL, by other DOE laboratories and by contractors funded directly by DOE or through PNL. The wind velocity change criteria for wind turbine design along with techniques for incorporating data into large area analysis are discussed. The publications on methodology for small wind energy conversion and wind forecasts are also reported. M.M.M.

**N79-19828 Cornell Univ., Ithaca, N. Y.**  
**THE ANAEROBIC ATTACHED FILM EXPANDED BED REACTOR FOR THE TREATMENT OF DILUTE ORGANIC WASTES Ph.D. Thesis**

Michael Samuel Switzenbaum 1978 205 p  
Avail: Univ. Microfilms Order No. 7902370

A process, the anaerobic attached film expanded bed reactor (AAFEB) has been found to be effective for the treatment of low strength soluble organic wastes anaerobically, at reduced temperatures, at short retention times, and at high organic loading rates. An analysis of the key process variables which affected AAFEB operation and two simplified first order equations relating the process efficiency to the net specific growth rate of the film and specific substrate utilization two widely used operational parameters which are based on fundamentals of microbial growth and energetics, are presented. Dissert. Abstr.

**N79-20109# Dynamics Research Corp., Wilmington, Mass. Systems Div.**

**AN ANALYSIS OF FUEL CONSERVING OPERATIONAL PROCEDURES AND DESIGN MODIFICATIONS FOR BOMBER/TRANSPORT AIRCRAFT, VOLUME 2 Final Report.**  
7 Jun. 1978 - 7 Jul. 1978

Romesh K. Aggarwal Jul. 1978 508 p refs  
(Contract F33615-76-C-3104)  
(AD-A062609; R-247U; AFFDL-TR-78-96-Vol-2) Avail: NTIS HC A22/MF A01 CSCL 01/3

Various proposed improvements in the design and operational procedures for bomber/transport aircraft are evaluated. The evaluation is performed in terms of the estimated savings in fuel consumption and in Direct Operating Cost (DOC). As an aid in the evaluation of design modifications, graphs of fuel and DOC savings as a function of the design parameters are developed. These graphs are based on actual mission trajectory data rather than some typical trajectory profile. The actual mission data is presented in terms of histograms which provide statistical information concerning altitude, air speed, take-off weight, landing weight, and mission time. Separate analyses are performed on the following aircraft: the B-52G, the B-52H, the KC-135, the C-141, the C-130, and the C-5A. Author (GRA)

**N79-20114#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**PARAMETRIC PERFORMANCE OF A TURBOJET ENGINE COMBUSTOR USING JET A AND A DIESEL FUEL**

Helmut F. Butze and Francis M. Humenik Mar. 1979 44 p refs  
(NASA-TM-79089; E-9913) Avail: NTIS HC A03/MF A01 CSCL 21E

The performance of a single-can JT8D combustor was evaluated with Jet A and a high-aromatic diesel fuel over a parametric range of combustor-inlet conditions. Performance parameters investigated were combustion efficiency, emissions of CO, unburned hydrocarbons, and NO<sub>x</sub>, as well as liner temperatures and smoke. At all conditions the use of diesel fuel instead of Jet A resulted in increases in smoke numbers and liner temperatures; gaseous emissions, on the other hand, did not differ significantly between the two fuels. Author

**N79-20118#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**TESTS OF NASA CERAMIC THERMAL BARRIER COATING FOR GAS-TURBINE ENGINES**

Curt H. Liebert 1979 10 p refs Presented at the Intern. Conf. on Met. Coatings, San Diego, Calif., 23-27 Apr. 1979 (NASA-TM-79116; E-9846-1) Avail: NTIS HC A02/MF A01 CSCL 21E

A two-layer thermal barrier coating system with a bond coating of nickel-chromium-aluminum-yttrium and a ceramic coating of yttria-stabilized zirconia was tested for corrosion protection, thermal protection and durability. Full-scale gas-turbine engine tests demonstrated that this coating eliminated burning, melting, and warping of uncoated parts. During cyclic corrosion resistance tests made in marine diesel fuel products of combustion in a burner rig, the ceramic cracked on some specimens. Metallographic examination showed no base metal deterioration. S.E.S.

**N79-20179#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**CLOSED LOOP SOLAR ARRAY-ION THRUSTER SYSTEM WITH POWER CONTROL CIRCUITRY Patent**

Robert P. Gruber, inventor (to NASA) Issued 6 Mar. 1979 8 p Filed 29 Mar. 1978 Supersedes N78-22149 (16 - 13, p 1673)  
(NASA-Case-LEW-12780-1; US-Patent-4,143,314;  
US-Patent-Appl-SN-891370; US-Patent-Class-323-15;  
US-Patent-Class-323-20) Avail: US Patent and Trademark Office CSCL 20C

A power control circuit connected between a solar array and an ion thruster receives voltage and current signals from the solar array. The control circuit multiplies the voltage and current signals together to produce a power signal which is differentiated with respect to time. The differentiator output is detected by a zero crossing detector and, after suitable shaping, the detector output is phase compared with a clock in a phase demodulator. An integrator receives no output from the phase demodulator when the operating point is at the maximum power but is driven toward the maximum power point for non-optimum operation. A ramp generator provides minor variations in the beam current reference signal produced by the integrator in order to obtain the first derivative of power.

Official Gazette of the U.S. Patent and Trademark Office

**N79-20272#** Naval Research Lab., Washington, D. C.  
**AGING BEHAVIOR OF CRUDE SHALE OIL Progress Report**

Robert N. Hazlett, James M. Hall, and Jack C. Burnett Aug. 1978 11 p refs  
(AD-A062420; AD-E000240; NRL-MR-3844) Avail: NTIS HC A02/MF A01 CSCL 11/8

Crude shale oil produced by the Paraho retort was heated for eight weeks at 50 C. This corresponds to at least one year of storage at ambient conditions. Increases in oil viscosity and in the content of high molecular weight compounds were observed, but pour point changes were minimal. The overall changes at the experimental conditions used are modest.

Author (GRA)

**N79-20279#** Southwest Research Inst., San Antonio, Tex. Army Fuels and Lubricants Research Lab.

**DIRECT UTILIZATION OF CRUDE OIL AS FUEL IN THE US ARMY FOUR-CYCLE DIESEL ENGINE, MODEL LDT-465-1C Interim Report, Apr. 1977 - Aug. 1978**

John V. Moffitt and Edwin A. Frame Aug. 1978 34 p refs  
(Contracts DAAG53-76-C-0003; DAAG70-78-C-0001)  
(AD-A062387; AFLRL-108) Avail: NTIS HC A03/MF A01 CSCL 21/7

Performance curves for the U.S. Army LDT-465-1C engine were obtained using DF-2 and crude oils of varying properties. A cyclic endurance test was run using crude oil as the fuel. The results of the crude oil fueled test were compared to tests where DF-2 fuel was used. The crude oil resulted in significantly more engine wear and deposition than the DF-2. With crude oil fuel, the lubricant was severely degraded at end of test.

Author (GRA)

**N79-20281#** Siltec Corp., Menlo Park, Calif.

**LSA LARGE AREA SILICON SHEET TASK CONTINUOUS LIQUID FEED CZOCHRALSKI GROWTH Quarterly Report, Oct. - Dec. 1978**

George Fiegl Jan. 1979 28 p Sponsored by DOE  
(Contract JPL-954886)  
(NASA-CR-158366; DOE/JPL-954886-79/1; QR-5) Avail: NTIS HC A03/MF A01 CSCL 13H

A process for the continuous growth of crystals by the Czochralski method, suitable for producing single silicon crystals for use in solar cells was studied. Continuous growth is the growth of 100 Kg of single silicon crystals, 10 cm in diameter, from one container. A furnace with continuous liquid replenishment of the growth crucible, accomplished by a melt-down system and a liquid transfer mechanism, with associated automatic feedback controls was developed. Elements of the transfer system were further developed and tested during actual transfer runs. Considerable simplification of the heating element of the transfer tube was achieved. Accuracy and reliability of the temperature sensor, which is part of the power input control system for the transfer tube, was improved. Electrical and thermal effectiveness were increased while assembly of the transfer tube system was further simplified.

Author

**N79-20282#** Westinghouse Research and Development Center, Pittsburgh, Pa.

**SILICON WEB PROCESS DEVELOPMENT Quarterly Report, 1 Oct. - 31 Dec. 1978**

C. S. Duncan, R. G. Seidensticker, R. H. Hopkins, J. P. McHugh, F. E. Hill, M. E. Heimlich, and J. M. Driggers 1978 118 p refs Prepared for JPL  
(Contract JPL-954654)  
(NASA-CR-158376; ERDA/JPL-954654-79/1) Avail: NTIS HC A06/MF A01 CSCL 13H

Progress in the development of techniques to grow silicon web at 25 wq cm/min output rate is reported. Feasibility of web growth with simultaneous melt replenishment is discussed. Other factors covered include: (1) tests of aftertrimmers to improve web width; (2) evaluation of growth lid designs to raise speed and output rate; (3) tests of melt replenishment hardware; and (4) investigation of directed gas flow systems to control unwanted oxide deposition in the system and to improve convective cooling of the web. Compatibility with sufficient solar cell performance is emphasized.

J.M.S.

**N79-20291#** National Bureau of Standards, Washington, D. C. National Engineering Lab.

**SOLAR BUILDING REGULATORY STUDY, VOLUME 2**

Joe Greenberg Nov. 1978 385 p  
(Contract EA-77-A-01-6010)  
(PB-289824/5; NBS-GCR-78-141-2-Vol-2) Avail: NTIS HC A17/MF A01 CSCL 13A

The results of a project oriented toward obtaining the views of organizations representing diversified interests within the building community are documented regarding: (1) the need for a solar regulatory systems; and (2) the form such a system should take if indeed a solar regulatory systems were recommended.

GRA

N79-20434

**N79-20434** California Inst. of Tech., Pasadena.  
**ANALYTICAL MODELLING OF OIL RECOVERY BY STEAM INJECTION Ph.D. Thesis**  
Yanis Christos Yortsos 1979 349 p  
Avail: Univ. Microfilms Order No. 7904856

An extensive study of the heat transfer in the surroundings and the hot liquid zone is carried out to complement the one-dimensional implementation of the technique. The resulting class of moving boundary problems and their methods of solution are discussed in detail. The results obtained are then combined with the integral technique to derive upper and lower bounds, asymptotic solutions and approximate solutions to the rate of growth of the steam zone. The important physical parameters are identified and their significance in the design of the process is outlined. For two- (three-) dimensional systems, a more detailed version of the integral method is developed to account for the effect of gravity segregation in the determination of the steam front shape. A non-linear partial differential equation that describes the evolution of the steam front shape in gravity dominated systems is derived. The significance of the various physical parameters in the performance of a three-dimensional steam injection process is discussed by providing a solution to the equation derived, in the limit of predominantly viscous flows.

Dissert. Abstr.

**N79-20458#** Los Alamos Scientific Lab., N. Mex.  
**TOWARD ASSESSING THE GEOTHERMAL POTENTIAL OF THE JEMEZ MOUNTAINS VOLCANIC COMPLEX: A TELLURIC-MAGNETOTELLURIC SURVEY**

John F. Hermance (Brown Univ.) Feb. 1979 88 p refs  
(Contract W-7405-eng-36)

(LA-7656-MS). Avail: NTIS HC A05/MF A01

Telluric-magnetotelluric studies were performed in the Jemez Mountains of north-central New Mexico to characterize the total geothermal system of the Valles Caldera and to be integrated with an east-west regional survey supported by the United States Geological Survey. The data from the regional survey indicate that electrically the San Juan Basin to the west of the Jemez Mountains is rather homogeneous in contrast to the eastern side near Las Vegas where the presence of a broad heterogeneous structure is clearly sensed. The data from the Jemez Mountain area are strikingly similar to other Rio Grande rift data and suggest a conducting layer at a depth of approximately 15 km. The telluric data indicate that the hydrothermal system in the area is of a localized nature.

Author

**N79-20459#** Colorado School of Mines, Golden. Dept. of Geophysics.

**RESEARCH ON THE PHYSICAL PROPERTIES OF GEOTHERMAL RESERVOIR ROCK** Quarterly Report

C. K. Skokan and A. Ibrahim Jul. 1978 65 p refs  
(Contract EY-76-S-02-2908)

(COO-2908-4). Avail: NTIS HC A04/MF A01

Laboratory measurements of thermal conductivity and capillary pressure undertaken for samples of Cenozoic Volcanic rocks collected from the Columbia Plateau Volcanic basin are presented. These measurements were performed at atmospheric pressure and room temperature. Various methods of measuring thermal conductivity were investigated and finally a flash method was chosen. The equipment was constructed and tested. Numerous capillary pressure curves were obtained by use of the mercury injection technique. These curves indicate pore structure: pore size, pore distribution, pore volume, and pore geometry. Measurements of this type help to explain variations in rock properties such as seismic velocities and resistivities.

J.M.S.

**N79-20478#** Alabama Univ. in Huntsville. Kenneth E. Johnson Environmental and Energy Center.

**COST ANALYSIS AND OPTIMIZATION STUDY FOR SOLAR HEATING AND COOLING SYSTEMS, STILLWATER, MINNESOTA AND NEWCASTLE, PENNSYLVANIA**

William L. Reid Nov. 1978 90 p  
(Contract NAS8-31293)

(NASA-CR-161201) Avail: NTIS HC A05/MF A01 CSCL 10A

A detailed cost analysis study of two solar energy systems was performed, in order to derive specific quantified and potential cost savings, design refinements, and/or design innovations for each of the selected solar energy systems represented by selected operational test sites. Preliminary cost estimates are given for liquid type systems based on the second series of operational test sites studied: Stillwater, Minnesota and New Castle, Pennsylvania.

J.M.S.

**N79-20480#** RCA Labs., Princeton, N. J.

**AUTOMATED ARRAY ASSEMBLY, PHASE 2** Quarterly Report, 1 Jul. - 30 Sep. 1978

R. V. Daiello Oct. 1978 42 p refs Sponsored in part by DOE

(Contract NAS7-100; JPL-954868)

(NASA-CR-158380; DOE/JPL-954868-78/4; QR-4) Avail: NTIS HC A03/MF A01 CSCL 10A

The purpose of the overall program is to establish technological readiness and provide verification for the elements of a manufacturing sequence which would ultimately be suitable for the large-scale production of silicon solar-array modules at a selling price of less than \$500/kW. A program and process plan for accomplishing this objective was developed and put into operation. Three junction-formation processes are shown; since cost analysis shows that they do not differ greatly in cost, each should be considered for technical merits and possible future cost reduction. The progress made in the various process steps of the plan is described, and conclusions are presented.

LS.

**N79-20481#** Lockheed Missiles and Space Co., Sunnyvale, Calif.

**AUTOMATED ARRAY ASSEMBLY, PHASE 2. LOW-COST SOLAR ARRAY PROJECT, TASK 4** Final Report

Mike Lopez Oct. 1978 112 p refs Sponsored by DOE

(Contract JPL-954898)

(NASA-CR-158365; LMSC-D632522; DOE/JPL-954898-78/4)

Avail: NTIS HC A06/MF A01 CSCL 10A

Work was done to verify the technological readiness of a select process sequence with respect to satisfying the Low Cost Solar Array Project objectives of meeting the designated goals of \$.50 per peak watt in 1986 (1975 dollars). The sequence examined consisted of: (1) 3 inches diameter as-sawn Czochralski grown 1:0:0 silicon, (2) texture etching, (3) ion implanting, (4) laser annealing, (5) screen printing of ohmic contacts and (6) sprayed anti-reflective coatings. High volume production projections were made on the selected process sequence. Automated processing and movement of hardware at high rates were conceptualized to satisfy the PROJECT's 500 MW/yr capability. A production plan was formulated with flow diagrams integrating the various processes in the cell fabrication sequence.

LS.

**N79-20482#** Schumacher (J. C.) Co., Oceanside, Calif.

**THE PRODUCTION OF SOLAR CELL GRADE SILICON FROM BROMOSILANES** Final Report

J. C. Schumacher, L. Woerner, E. Moore, and C. Newman Jan. 1979 70 p refs Sponsored in part by DOE

(Contract JPL-954914)

(NASA-CR-158362; SE-855; DOE/JPL-954914-78/2) Avail:

NTIS HC A04/MF A01 CSCL 10A

A continuous Flow Reactor (CFR) process based on the hydrogen reduction of the bromosilanes SiBr<sub>4</sub> and SiHBr<sub>3</sub> was proposed. Initial experiments carried and directed at obtaining overall yield data for bromosilane reduction in the CFR, indicated the need for increased reactor residence time and deposition substrate particle packing density to fully characterize the kinetics (rate) and thermodynamics (yield) of observed silicon production. Fluidized bed experiments were therefore initiated to overcome these experimental difficulties, which showed both thermal decomposition and hydrogen reduction of SiHBr<sub>3</sub> in a fluid bed reactor to present attractive closed-loop processes for producing solar cell grade polycrystalline silicon. No process selection could be made however due to the fact that preliminary optimization of 2 or 3 process stages in each case during the course of the experimental program showed comparable attainment of cost element objectives.

J.M.S.

N79-20403// Mobil Tyco Solar Energy Corp., Waltham, Mass.  
 LARGE AREA SILICON SHEET BY EFG  
 Annual Progress Report, 1 Oct 1977 - 30 Sep. 1978  
 F. V. Wald 16 Feb. 1979 78 p refs Prepared for JPL  
 (Contract JPL-954355)

(NASA-CR-158379; DOE/JPL-954355-78/3) Avail: NTIS  
 HC A05/MF A01 CSCL 10A

Progress made in the development of EFG ribbon growth is discussed. Specific areas covered include: (1) demonstration of multiple growth for ribbons 5 cm wide in runs of 12 and 20 hours duration; (2) a single cartridge crystal growth station was built expanding observational capacity by virtue of an anamorphic optical-video system which allows close observation of the meniscus over 7.5 cm wide, as well as video taping of the ribbon growth process; (3) growth station no. 1 achieved reproducible and reliable growth of 7.5 cm wide ribbon at speeds up to 4 cm/min; (4) introduction of the 'mini cold shoe'; (5) increases in cell efficiency due to interface shaping using the 'displaced die' concept; and (6) clarification of the role of gaseous impurities in cartridge furnaces and stabilization of their destabilizing influence on growth.

J.M.S.

N79-20404// Westinghouse Research and Development Center, Pittsburgh, Pa.

PHASE TWO OF THE ARRAY AUTOMATED ASSEMBLY TASK FOR THE LOW COST SOLAR ARRAY PROJECT  
 Quarterly Report, 1 Oct. - 31 Dec. 1978

R. B. Campbell, D. J. Page, P. Rei-Choudhury, E. J. Seman, M. H. Hanes, A. Rohatsi, and J. R. Davis 31 Jan. 1979 44 p refs Sponsored in part by DOE  
 (Contracts NAS7-100; JPL-954873)

(NASA-CR-158359; QR-5) Avail: NTIS HC A03/MF A01 CSCL 10A

Various top contact metal systems were studied. Only Ti/Pd/Cu approaches baseline (Ti/Pd/Ag) quality, but this system shows a lack of long term stability. Aluminum back surface field structures were fabricated and thicknesses of  $\mu$  superscript + material of up to 7.0 microns were achieved with open circuit voltages of 0.59V. A general purpose ultrasonic welder was purchased and tests using various metal foils are under way. During fabrication of the demonstration module, several cells became cracked. Due to redundancy of interconnections, the module was not open circuited but the efficiency was reduced to 8.8%. The broken cell was interconnected with a strap across the back and the efficiency was increased to 11.5%. A cost analysis was made and the results indicate a selling price of \$0.56/watt peak (in 1986 with 1975 dollars).

L.S.

N79-20405// Optical Coating Lab., Inc., City of Industry, Calif.  
 Photoelectronics Div.

SILICON SOLAR CELL PROCESS DEVELOPMENT, FABRICATION AND ANALYSIS Quarterly Report, 1 Oct. - 31 Dec. 1978

H. I. Yoo, P. A. Iles, and D. P. Tanner 31 Dec. 1978 71 p refs Sponsored in part by DOE  
 (Contract JPL-955089)

(NASA-CR-158363; DOE/JPL-955089-79/1; QR-2) Avail:  
 NTIS HC A04/MF A01 CSCL 10A

Ribbon to Ribbon (RTR) solar cells processed from polycrystalline feedstock showed maximum AMO efficiency of 5.6%. Solar cells from single crystalline feedstock showed slightly higher efficiency than those from polycrystalline feedstock, indicating maximum efficiency of about 6.6% with SiO AR coating. Single crystalline control cells gave 11-12% AMO efficiencies demonstrating that the poor performance of the RTR solar was due to the low quality of material itself. Dendritic web solar cells from the standard process showed maximum AMO efficiency of 9.8% while efficiency of control solar cells were around 11-12%. Web solar cells from back surface field (BSF) process indicated maximum AMO efficiency of 10.9%. Some improvement in open circuit voltage was noticed from the BSF process. Small light spot scanning experiments were carried out on the solar cells from Wacker Silso, EFG, RTR, and dendritic web ribbons. Photoreponse results provided information on localized cell performance and grain size in polycrystalline material, and agreed quite well with the cell performance data, such as efficiency, minority carrier diffusion length, and spectral response.

L.S.

N79-20403// Ross (Bernd) Associates, San Diego, Calif.  
 DEVELOPMENT OF ECONOMICAL IMPROVED THICK FILM  
 SOLAR CELL CONTACT Quarterly Report  
 Bernd Ross and David Mentley Jan. 1979 45 p refs Sponsored  
 by NASA Prepared for DOE and JPL  
 (Contract JPL-955164)  
 (NASA-CR-158358; DOE/JPL-955164-78/4; QR-1) Avail:  
 NTIS HC A03/MF A01 CSCL 10A

Materials were surveyed to provide candidates for an all metal electrode paste system. These consisted of a major constituent metal powder, a low melting metal powder suitable for a liquid phase sintering medium, and a powder material suitable as an etchant for silicon dioxide at sintering temperatures. By means of thermal gravimetric analysis a suitable binder was identified for low temperature fired inks. The all metal ink concept was first demonstrated with the silver system to avoid the problems of limited process windows encountered with base metal systems. A number of solid materials capable of selectively etching silicon dioxide at modest temperatures were identified. A paste with silver fluoride was screened onto N-type silicon with 5 ohm cm resistivity. The resulting contact pads had excellent adhesion but were not electrically ohmic. Metallurgically, these contacts have equal or better grain structure as commercial inks fired at the same temperatures.

Author

N79-20407// West Virginia Univ., Morgantown.  
 SIMULATION OF FLUIDIZED BED COAL COMBUSTORS  
 Final Report  
 Renga Rajan Feb. 1979 215 p refs  
 (Grant NSG-3134)  
 (NASA-CR-159529) Avail: NTIS HC A10/MF A01 CSCL 10B

The many deficiencies of previous work on simulation of fluidized bed combustion (FBC) processes are presented. An attempt is made to reduce these deficiencies, and to formulate a comprehensive FBC model taking into account the following elements: (1) devolatilization of coal and the subsequent combustion of volatiles and residual char; (2) sulfur dioxide capture by limestone; (3) NO<sub>x</sub> release and reduction of NO<sub>x</sub> by char; (4) attrition and elutriation of char and limestone; (5) bubble hydrodynamics; (6) solids mixing; (7) heat transfer between gas and solid, and solid and heat exchange surfaces; and (8) freeboard reactions.

G.Y.

N79-20409// Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
 A FIXED TILT SOLAR COLLECTOR EMPLOYING REVERCIBLE VEE-THROUGH REFLECTORS AND EVALUATED  
 TUBE RECEIVERS FOR SOLAR HEATING AND COOLING SYSTEMS

M. Kudret Selcuk Oct. 1978 95 p refs  
 (Contract NAS7-100)  
 (NASA-CR-158420; DOE/JPL-1024-78/1; JPL-Pub-78-106)  
 Avail: NTIS HC A05/MF A01 CSCL 10A

The Vee-Trough/Evacuated Tube Collector (VTETC) was analyzed rigorously and various mathematical models were developed to calculate the optical performance of the vee-trough concentrators, and the quasi-steady state thermal performance of the evacuated tube receivers. Tests were run to verify the mathematical analyses. Back-silvered glass mirror, Alzak, Aluminized Teflon, and Kinglux (electropolished aluminum reflectors) were tested. Additional tests were run at temperatures ranging from 80 to 190 C (176-374 F). For the glass mirror reflectors, peak efficiencies, based on aperture area and operating temperatures of 125 C (257 F), were over 40%. Efficiencies of about 40% were observed at temperatures of 150 C (302 F) and 30% at 175 C (347 F). Test data for several days, predicted daily useful heats, and efficiency values are presented for a full year. These theoretical values were then compared with actual data points for the same temperature range.

F.O.S.

N79-20410// Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
 THE PARABOLIC CONCENTRATING COLLECTOR: A  
 TUTORIAL  
 V. C. Truscello 1 Mar. 1979 47 p Prepared for DOE  
 (Contract NAS7-100)  
 (NASA-CR-158246; DOE/JPL-1080-79/1; JPL-Pub-79-7)

N79-20492

Rept-5102-107) Avail: NTIS HC A03/MF A01 CSCL 10A

A tutorial overview of point-focusing parabolic collectors is presented. Optical and thermal characteristics are discussed. Data representing typical achievable collector efficiencies are presented and the importance of balancing collector cost with concentrator quality is argued through the development of a figure of merit. Various types of two-axis tracking collectors are described. The Department of Energy program to develop these devices is briefly discussed, as are present and projected costs for these collectors.

G.Y.

N79-20402<sup>1/</sup> Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. THERMAL POWER SYSTEMS POINT-FOCUSING DISTRIBUTED RECEIVER TECHNOLOGY PROJECT. VOLUME 1: EXECUTIVE SUMMARY Annual Report

John Lucas 15 Feb. 1979 31 p

(Contract NAS7-100)

(NASA-CR-158421; DOE/JPL-1080-7; JPL-Pub-79-1-Vol-1;

Rept-5104-26-Vol-1: JPL-5104-26) Avail: NTIS

HC A03/MF A01 CSCL 10A

Thermal or electrical power from the sun's radiated energy through Point-Focusing Distributed Receiver Technology is the goal of this project. The energy thus produced must be technically, as well as economically, competitive with other energy sources. This project is to support the industrial development of the required technology to achieve the above stated goal. Solar energy is concentrated by either a reflecting surface or a lens to a receiver where it is transferred to a working liquid or gas. Receiver temperatures are in the 1000 - 2000 F range. Conceptual design studies are expected to identify power conversion units with a viable place in the solar energy future. Rantine and Brayton cycle engines are under investigation. This report details the Jet Propulsion Laboratory's accomplishments with point-focusing technology in Fy 1978.

Author

N79-20403<sup>1/</sup> Colt, Inc. of Southern California, Rancho Mirage. VERIFICATION TEST REPORT ON A SOLAR HEATING AND HOT WATER SYSTEM

21 Jul. 1978 60 p Prepared for DOE

(Contract NAS8-32242)

(NASA-CR-161165) Avail: NTIS HC A04/MF A01 CSCL 10A

Information is provided on the development, qualification and acceptance verification of commercial solar heating and hot water systems and components. The verification includes the performances, the efficiencies and the various methods used, such as similarity, analysis, inspection, test, etc., that are applicable to satisfying the verification requirements.

G.Y.

N79-20404<sup>1/</sup> National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

UTILITY OPERATIONAL EXPERIENCE ON THE NASA/DOE MOD-0A 200-kW WIND TURBINE

J. C. Glasgow and W. H. Robbins 1979 30 p refs Presented at the 6th Energy Technol. Conf., Washington, D. C., 26-28 Feb. 1979; sponsored by Am. Gas. Assoc. - Gas. Res. Inst., Elec. Power Res. Inst., and Thomas Alva Edison Found.

(Contract E(49-26)-1004)

(NASA-TM-79084; E9907; DOE/NASA/1004-79/1) Avail: NTIS HC A03/MF A01 CSCL 10B

The Mod-0A 200 wind turbine was designed and fabricated as part of the Federal Wind Energy Program. Early wind turbine operation and performance data were obtained while gaining initial experience in the operation of large, horizontal axis wind turbines in typical utility environments. The Mod-0A wind turbine was turned over to the Town of Clayton Light and Water Plant, Clayton, NM, for utility operation and on December 31, 1978, the machine had completed ten months of utility operation. The machine is described and the recent operational experience at Clayton, NM is documented.

J.M.S.

N79-20405<sup>1/</sup> National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

PERFORMANCE CHARACTERISTICS OF A 1.8 BY 3.7 METER FRESNEL LENS SOLAR CONCENTRATOR

Leon J. Hastings and Steve L. Allums 12 Feb. 1979 25 p refs Backup document for AIAA Synoptic scheduled for publication in Journal of Energy, Mar. - Apr. 1979  
(NASA-TM-78222; EP43-79-5) Avail: NTIS HC A02/MF A01 CSCL 10A

Line-focusing acrylic Fresnel lenses with application potential in the 200 to 370 C range were analytically and experimentally investigated. The measured solar concentration characteristics of a 1.8 by 3.7 m lens and its utilization in a solar collection mode are presented. A measured peak concentration ratio of 62 with 90 percent of the transmitted energy focused into a 5.0cm width was achieved. A peak concentration of 59 and a 90 percent target width of 4.3 cm were analytically computed. The experimental and analytical lens transmittance was 78 percent and 86 percent, respectively. The lens was also interfaced with a nonevacuated receiver assembly and operated in the collection mode. With a natural oxide absorber tube coating ( $\alpha/\epsilon = 0.79/0.10$ ), the measured collection efficiency ranged from 43 percent to 200 C to 34 percent at 260 C. Efficiency improvements to the 40 to 50 percent range can be achieved with second generation lenses and higher performance absorptive coatings.

Author

N79-20407<sup>1/</sup> Technical Report Services, Rocky River, Ohio. EVALUATION OF URETHANE FOR FEASIBILITY OF USE IN WIND TURBINE BLADE DESIGN Final Report Seymour Lieblein, Robert S. Ross (Concept Development Inst., Hudson, Ohio), and Demeter G. Fertis (Akron Univ.) Apr. 1979 156 p  
(NASA Order C-7653; Contract E(49-26)-1028)  
(NASA-CR-159530; DOE/NASA/7653-79/1; TRS-101) Avail: NTIS HC A08/MF A01 CSCL 10B

A preliminary evaluation was conducted of the use of cast urethane as a possible material for low-cost blades for wind turbines. Specimen test data are presented for ultimate tensile strength, elastic modulus, flexural strain, creep, and fatigue properties of a number of urethane formulations. Data are also included for a large-scale urethane blade section composed of cast symmetrical half-profiles tested as a cantilever beam. Based on these results, an analysis was conducted of a full-scale blade design of cast urethane that meets the design specifications of the rotor blades for the NASA/DOE experimental 100-kW MOD-0 wind turbine. Because of the low value of elastic modulus for urethane (around 457 000 psi), the design loads would have to be carried by metal reinforcement. Considerations for further evaluation are noted.

Author

N79-20408<sup>1/</sup> National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THERMAL STORAGE TECHNOLOGIES FOR SOLAR INDUSTRIAL PROCESS HEAT APPLICATIONS

Larry H. Gordon 1979 19 p refs

(Contract EC-77-A-31-1034)

(NASA-TM-79130; DOE/NASA/1034-79/2; E-9970) Avail: NTIS HC A02/MF A01 CSCL 10A

The state-of-the-art of thermal storage subsystems for the intermediate and high temperature (100 C to 600 C) solar industrial process heat generation is presented. Primary emphasis is focused on buffering and diurnal storage as well as total energy transport. In addition, advanced thermal storage concepts which appear promising for future solar industrial process heat applications are discussed.

J.M.S.

N79-20409<sup>1/</sup> Alabama Univ. in Huntsville. Kenneth E. Johnson Environmental Energy Center.

COST ANALYSIS AND OPTIMIZATION STUDY FOR SOLAR HEATING AND COOLING SYSTEMS

William L. Reid and Robert E. Shannon Jan. 1979 51 p refs

(Contract NAS8-31293)

(NASA-CR-161200) Avail: NTIS HC A04/MF A01 CSCL 10A

Detailed cost analyses of two operational test sites which are a part of a solar energy development program are presented. Actual costs and potential cost improvements of new and retrofit solar space conditioning and hot water systems for single family

sized housing were studied. Operational test sites were used for evaluation as these projects are a part of the National Solar Heating and Cooling Demonstration Program. During the period involved in the initial cost analysis of the solar project, it became evident that a comparison of solar system costs with conventional heating, cooling, and hot water systems on a first cost basis was not sufficient for an overall view of life cycle costs for the consumer.

J.M.S.

**N79-20500#** Argonne National Lab., Ill.  
**MDH BALANCE OF PLANT TECHNOLOGY PROJECT Quarterly Report, 1 Apr. 1978 - 30 Jun. 1978**  
 Michael Petrick, Kenneth E. Tempelmeyer, and Terry R. Johnson Aug. 1978 62 p refs  
 (Contract W-31-109-eng-38)

(ANL-MHD-78-7; QR-2) Avail: NTIS HC A04/MF A01

The design and operation of the heat and seed recovery systems downstream of channel-diffuser and to the seed regeneration processes were studied. Engineering data needed to design components in MHD prototype and demonstration facilities were obtained. Activities discussed include: (1) preparation of a national program plan for heat and seed recovery systems; (2) analytical modeling of the heat transfer and seed-slag separation processes in the radiant boiler; (3) modeling of the formation growth, and behavior of slag and seed particles in the combustion gas stream; (4) studies of the thermochemistry of seed-slag systems; (5) investigations of ceramic and metallic materials for use in the downstream gas systems; (6) small-scale engineering studies of seed-slag deposition; (7) design and construction of a 2-MW experimental facility for investigations pertaining to the downstream gas system, and (8) evaluations of seed regeneration processes.

J.M.S.

**N79-20502#** Brookhaven National Lab., Upton, N. Y.  
**METHODOLOGY FOR MODELING GEOTHERMAL DISTRICT HEATING FOR RESIDENTIAL MARKETS**  
 John Karkheck and Raymond G. Tessmer, Jr. Aug. 1978 26 p refs  
 (Contract EY-76-C-02-0016)

(BNL-50905) Avail: NTIS HC A03/MF A01

Methodology is presented for modeling geothermal district heat service and for evaluating the economic market potential for such nonelectrical utilization of the geothermal resource. It is based upon accurate determination of the heating demand and its spatial and temporal profile in each potential market, determination of the cost to provide such service, and correlation of markets and resource sites. Two components of the model are discussed. The residential demand submodel and data base projects heating demand densities and temporal profiles along with building service modifications and costs. The service submodel and data base design and costs a subtransmission and distribution network, and it evaluates operating losses at design conditions.

Author

**N79-20503#** Argonne National Lab., Ill. Engineering Div.  
**PARAMETRIC STUDY OF THE PERFORMANCE OF A CDIF 1-B COAL-FIRED MHD GENERATOR**  
 R. K. Ahluwalia, H. K. Geyer, and E. D. Doss Feb. 1979 51 p refs  
 (Contract W-31-109-eng-38)

(ANL-MHD-79-3) Avail: NTIS HC A02/MF A01

A comprehensive study is conducted into the analysis of a coal-fired Component Development and Integration Facility (CDIF) 1-B channel performance to simulate the characteristics of the reference Engineering Test Facility (ETF) channel. The performance criteria are established by careful review of the role played by the gas dynamic and electrical variables in determining channel behavior. On the basis of this review, a constant-velocity subsonic channel operating at nominal combustor pressure of 5.4 atm (0.54 MPa) is selected. The channel loading is selected to obtain a maximum Hall field of 2.4 kV/m and maximum transverse current density of 1.1 A/sq cm.

Author

**N79-20504#** Battelle Pacific Northwest Labs., Richland, Wash.  
**DEVELOPMENT, CHARACTERIZATION AND EVALUATION OF MATERIALS FOR OPEN CYCLE MHD** Quarterly Report, period ending Jun. 1978

J. Lambert Bates, D. D. Marchant, and J. L. Daniel Oct. 1978  
 65 p refs  
 (Contract EY-76-C-06-1830)  
 (PNL-2004-9) Avail: NTIS HC A04/MF A01

The program is directed toward the development and characterization of high temperature ceramics for open-cycle, coal-fired MHD power generators. The current activities are directed to electrode and insulator materials, and include: (1) determination of the effects of alkali seed on the behavior of ceramics in a dc electric field; (2) development and testing of improved high temperature ceramic electrodes and insulators with controlled composition, microstructure, and properties; and (3) characterization and evaluation of materials utilized in channels being tested for MHD power generator development.

G.Y.

**N79-20505#** United Technologies Corp., South Windsor, Conn. Power Systems Div.  
**VENTURE ANALYSIS CASE STUDY FOR ON-SITE FUEL CELL ENERGY SYSTEMS Final Report**  
 P. Bolan, P. Farris, and S. Folstad 31 Jul. 1978 76 p  
 (Contract EX-77-C-01-2684)

(FCR-0783-Vol-1) Avail: NTIS HC A05/MF A01

The benefits and the consequences of commercialization of on-site fuel cell energy systems were evaluated. In the business venture selected for this case study, gas utility companies would own and operate efficient, clean, quiet fuel cell power plants on the customer's premises and provide electrical and thermal energy services to the consumer upon demand. For each building, an integrated energy system is assumed where the fuel cell provides all of the electricity for lights and equipment; fuel cell heat is recovered for space and water heating; and fuel cell driven heat pumps, utilizing replenishable energy from the surroundings, provide space heating and cooling. Very high fuel utilization efficiencies, in the neighborhood of 100 percent, were measured in testing this type system. Success of this energy service venture depends upon gas company marketing and servicing efforts, and upon the manufacturer supplying reliable and economical fuel cell power plants.

J.M.S.

**N79-20506#** Battelle Pacific Northwest Labs., Richland, Wash.  
**WIND DIRECTION CHANGE CRITERIA FOR WIND TURBINE DESIGN**  
 W. C. Cliff Jan. 1979 17 p refs  
 (Contract EY-76-C-06-1830)

(PNL-2531) Avail: NTIS HC A02/MF A01

A method is presented for estimating the root mean square (rms) value of the wind direction change, Delta Theta (tau) = theta (tau + tau) - Theta (tau), that occurs over the swept area of wind turbine rotor systems. An equation is also given for the rms value of the wind direction change that occurs at a single point in space, i.e., a direction change that a wind vane would measure. Equations are given for calculating the expected number of wind direction changes, larger than an arbitrary value, that will occur in 1 hr as well as the expected number that will occur during the design life of a wind turbine. The equations are developed using a small angle approximation and are, therefore, considered appropriate for wind direction changes of less than 30 degrees. The equations are based upon neutral atmospheric boundary-layer conditions.

G.Y.

**N79-20507#** Argonne National Lab., Ill.  
**TECHNICAL SUPPORT FOR OPEN-CYCLE MHD PROGRAM Progress Report, 1 Jan. - 31 Mar. 1978**  
 J. Patten, ed. May 1978 104 p refs  
 (Contract W-31-109-eng-38)

(ANL-MHD-78-8) Avail: NTIS HC A06/MF A01

The support program for open-cycle MHD (magnetohydrodynamic) at Argonne National Lab is developing the analytical tools needed to investigate the performance of the major components in the combined-cycle MHD/steam power system. The analytical effort is centered on the primary components of the system that are unique to MHD and also on the integration of these analytical representations into a model of the entire power producing system. The present project activities include modeling of the combustor, MHD channel, slag separator, and the high-temperature air preheater. These models are combined into

## N79-20508

a complete system model, which is at present capable of carrying out optimizations of the entire system on either thermodynamic efficiency or with less confidence, cost of electrical power.

Author

N79-20503// Edgerton, Germeshausen and Grier, Inc., Idaho Falls, Idaho.

### MEASUREMENT AND CONTROL TECHNIQUES IN GEOTHERMAL POWER PLANTS

J. F. Whitbeck, R. H. Dart, J. D. Miller, and D. R. Brewer (Rogers Engineering) Jan. 1979 80 p refs  
(Contract EY-76-C-07-1570)

(TREE-1312) Avail: NTIS HC A05/MF A01

The background and source material used in preparing the chapter of the Geothermal Source Book on instrumentation, measurement, and control techniques is provided. Included are detailed examples of instrumentation and control techniques currently being used in geothermal power plants. In addition, the basic guidelines and unique characteristics of instrumentation and control in geothermal systems, are presented.

G.Y.

N79-20503// Department of Energy, Washington, D. C. Office of Energy Use Analysis.

### MEASURING ENERGY CONSERVATION

Dec. 1978 44 p refs  
(DOE/EIA-0103/18: TM/EU/79-06) Avail: NTIS HC A03/MF A01

The meaning of energy conservation is briefly examined and alternative methods for measuring energy conservation are described. Current methods employed to forecast the impacts of energy conservation programs are included along with energy models, capable of analyzing the impacts of energy conservation legislation or the use of more energy-efficient equipment. J.M.S.

N79-20510// TRW Defense and Space Systems Group, Redondo Beach, Calif.

HIGH PRESSURE MHD COAL COMBUSTORS INVESTIGATION Quarterly Technical Progress Report, 15 May - 15 Aug. 1978

John A. Hardgrove 15 Aug. 1978 52 p

(Contract ET-78-C-01-2706)

(FE-2706-08; QTPR-2) Avail: NTIS HC A04/MF A01

Progress during this reporting period included the following: Assembled and checked out the combustor and instrumentation; completed design of the average conductivity section; conducted over-drying tests of coal in 50-lb paper bags; conducted 32 combustor test firings; investigated the effects of first stage stoichiometry and coal injector configuration and position; tested a technique for mechanically retaining slag on the combustor walls; set up and tested the seed injection system; and used the breadboard sodium D-line temperature measuring equipment for plasma thermal characterization during three coal firing tests.

G.Y.

N79-20511// Massachusetts Inst. of Tech., Cambridge. Energy Lab.

CRITICAL CONTRIBUTIONS IN MHD POWER GENERATION Quarterly Technical Progress Report, 1 Dec. 1977 28 Feb. 1978

J. F. Louis Mar. 1978 179 p refs

(Contract EF-76-C-01-2215)

(FE-2215-11) Avail: NTIS HC A09/MF A01

During the last year work was focused primarily on electrode and insulator systems for the generator. The major results reported were the engineering data for the spinel module. The current thrust is on superhot wall materials based on zirconates. New and important results from the laboratory measurements were translated into working electrode modules. Detailed description of technical progress is given for the following tasks: (1) electrode module materials evaluation; (2) electrode module development; (3) coal combustion studies; (4) critical phenomena in MHD generators; (5) studies in a disk generator; (6) MHD component modeling; (7) MHD generator modeling; (8) participation in US USSR cooperative MHD program; and (9) Dept. of Energy/MHD Program support.

G.Y.

N79-20512// Stanford Univ., Calif.

### AXIAL FIELD LIMITATIONS IN MHD GENERATORS

William C. Unkel Apr. 1978 392 p refs

(Contract EX-76-C-01-2341)

(FE-2341-8) Avail: NTIS HC A17/MF A01

The results of an investigation of axial field breakdown in nonslagging wall, combustion driven MHD generators are presented. Breakdown was characterized by a rapid decline in axial voltage and a change in the mode of current transport from a relatively diffuse mode to a highly constricted and extremely destructive mode. Cinephotographic records demonstrated that breakdown could be initiated in the plasma or in the interelectrode insulator. Plasma initiated and insulator initiated breakdown resulted only when a threshold voltage was exceeded. For the electrode wall configuration studied, the threshold voltage for plasma initiated breakdown was significantly higher than the threshold voltage for insulator initiated breakdown. Electro-thermal instability was responsible for the behavior observed in the experiments. A computer model was developed to predict the nonbreakdown and incipient breakdown behavior for the simplified configuration.

Author

N79-20513// National Aeronautics and Space Administration, Pasadena Office, Calif.

### AN IMPROVED SOLAR ENERGY RECEIVER FOR A STIRLING ENGINE Patent Application

M. Kudret Selcuk, inventor (to NASA) (JPL) Filed 6 Apr. 1979 12 p

(Contract NAS7-100)

(NASA-Case-NPO-14619-1; US-Patent-Appl-SN-027559) Avail: NTIS HC A02/MF A01 CSCL 10A

Damage to a Stirling engine is prevented by using a solar receiver of separable configuration to reduce solar flux density in order to protect the heat exchanger contained within the receiver. A solar energy receiver includes a separable endless wall formed of a ceramic material in which a cavity of a substantially cylindrical configuration is defined for entrapping solar flux. An acceptance aperture admits a concentrated beam of solar energy to the cavity. The wall is characterized by at least one pair of contiguously related segments separated by lines of cleavage intercepting the aperture. At least one of the segments is supported for pivotal displacement. A thermal responsive actuator is adapted to respond to excessive temperatures within the cavity for initiating pivotal displacement of one segment, so that thermal flux is permitted to escape from the cavity.

NASA

N79-20514// Department of Energy, Washington, D. C. ENVIRONMENTAL IMPACT DETERMINATION OF ACTION TO BE TAKEN UNDER THE ENERGY SUPPLY AND ENVIRONMENTAL COORDINATION ACT FOR POWER PLANTS 1, 2, 3, AND 4, PORTSMOUTH GENERATING STATION, PORTSMOUTH, VIRGINIA

Mar. 1978 119 p refs

(DOE/EA-0033) Avail: NTIS HC A08/MF A01

An environmental assessment of the proposed Notice of Effectiveness is given to make effective the prohibition order prohibiting burning of gas or oil as the primary energy source at the Portsmouth Generating Station power plants (Virginia Electric Power Company). A description of the facility and its surroundings, along with alternative generating station operations are discussed. Conversion effects on: air quality; land use/solid wastes; water quality and uses; ecosystems; and esthetics, are also discussed.

G.Y.

N79-20515// General Electric Co., Philadelphia, Pa. Space Div.

### MHD-ETF PROGRAM. VOLUME 1: EXECUTIVE SUMMARY Final Report, 4 Jun. 1977 - 4 Mar. 1978

Mar. 1978 56 p

(Contract EF-77-C-01-2613)

(FE-2613-6-Vol-1) Avail: NTIS HC A04/MF A01

A conceptual design study was performed to establish a reference design for a magnetohydrodynamic engineering test facility (MHD-ETF). Alternative conceptual designs were developed to the point where an evaluation and selection of a

preferred concept could be made. The preferred conceptual design was then updated to provide an ETF reference design. Capital cost estimates and operating and maintenance cost estimates were then prepared. Critical advanced technology development requirements were identified. The ETF system configuration is a 250 MWt size, coal fired, MHD/Steam combined cycle plant.

Author

**N79-20516#** General Electric Co., Philadelphia, Pa. Space Div.

**MHD-ETF PROGRAM. VOLUME 2A, PARTS 1 AND 2: REFERENCE DESIGN DESCRIPTION** Final Report, 4 Jan. 1977

Mar. 1978 238 p refs  
(Contract EF-77-C-01-2613)

(FE-2613-6-Vol-2A) Avail: NTIS HC A11/MF A01

Volume 2A, Parts 1 and 2, of a multivolume report is given. Part 1 gives a system design description and rationale and discusses the following: groundrules, size and flexibility; degree of slag rejection; NO<sub>x</sub> prediction and its influence on the system; supercritical vs. subcritical boiler; system configuration (and with bottom only); performance analysis; system operation; and reliability and maintainability. Part 2 gives the plant design description and includes discussion on the following: site; plant buildings, structures and improvements; boiler plant; steam turbine (generator and auxiliaries); accessory electrical equipment (production plant); miscellaneous power plant equipment; magnetohydrodynamic cycle equipment; research equipment and centralized instrumentation and control equipment; and transmission plant. G.Y.

**N79-20517#** Montana Energy and MHD Research and Development Inst., Inc., Butte.

**MHD POWER GENERATION: RESEARCH, DEVELOPMENT AND ENGINEERING Quarterly Progress Report, Jan. - Mar. 1978**

Mar. 1978 259 p refs  
(Contract EF-77-C-01-2524)

(FE-2524-8) Avail: NTIS HC A13/MF A01

A special compilation of several task reports under contract to the U. S. Department of Energy is presented. Summarizing the work accomplished from January to March 1978, the reports cover the MERDI (Montana Energy and MHD Research and Development Institute) Materials Evaluation task and the tasks being performed by the Montana College of Mineral Science and Technology and Montana State University. G.Y.

**N79-20518#** Montana Energy and MHD Research and Development Inst., Inc., Butte.

**MHD POWER GENERATION: RESEARCH, DEVELOPMENT AND ENGINEERING Quarterly Progress Report, Apr. - Jun. 1978**

Jun. 1978 209 p refs

(Contract ET-78-C-01-3087)

(FE-3087-2) Avail: NTIS HC A10/MF A01

The Montana Energy and MHD Research and Development Institute (MERDI) was established in Butte, Montana in 1974 to develop methods for conserving western energy sources and to carry out supporting science and technology tasks for the national magnetohydrodynamic (MHD) program. Under contract to the U.S. Department of Energy, these tasks were divided among researchers at MERDI, the Montana Colleges of Mineral Science and Technology (MCMST), and Montana State University (MSU). The work accomplished by MERDI, MCMST, and MSU from April through June 1978 are summarized. G.Y.

**N79-20619#** North Carolina Science and Technology Research Center, Research Triangle Park.

**AN ANALYTICAL INVESTIGATION OF THE PERFORMANCE OF SOLAR COLLECTORS AS NIGHTTIME HEAT RADIA-TORS IN AIRCONDITIONING CYCLES** Final Report

Clay B. Jones and Frederick O. Smetana Mar. 1979 62 p refs  
(Contract NAS1-14208)

(NASA-CR-3111) Avail: NTIS HC A04/MF A01 CSCL 10A

It was found that if the upper and lower ends of a collector were opened, large free convection currents may be set up

between the collector surface and the cover glass(es) which can result in appreciable heat rejection. If the collector is so designed that both plates surfaces are exposed to convection currents when the upper and lower ends of the collector enclosure are opened, the heat rejection rate is 300 watts sq m when the plate is 13 C above ambient. This is sufficient to permit a collector array designed to provide 100 percent of the heating needs of a home to reject the accumulated daily air conditioning load during the course of a summer night. This also permits the overall energy requirements for cooling to be reduced by at least 15 percent and shift the load on the utility entirely to the nighttime hours.

Author

**N79-20522#** Army Construction Engineering Research Lab., Champaign, Ill.

**DESIGN OF SOLAR HEATING AND COOLING SYSTEMS Final Report**

David M. Jencich, Donald James Leverenz, Douglas C. Hittle, and George N. Walton Oct. 1978 59 p refs  
(DA Proj. A47-62731-AT-41)  
(AD-A062719; CERL-TR-E-139) Avail: NTIS HC A04/MF A01 CSCL 13/1

This report presents a method for making an energy and an economic cost/benefit analysis of solar energy systems. A graphical method is presented for evaluating the performance of solar domestic hot water system, solar heating systems, and solar heating and cooling systems. Methods for selecting the optimum collector area based on benefit-to-cost ratio and for systematically making detailed design calculations using the Building Loads Analysis and System Thermodynamics (BLAST) computer simulation program are also presented. Practical considerations for solar system designs are discussed. The methods presented provide the required accuracy for both initial evaluations and final design calculations. Examples are provided throughout the text to aid in using the methods described. Author (GRA)

**N79-20524#** National Bureau of Standards, Washington, D. C. Building Economics and Regulatory Technology Div.

**LABORATORIES TECHNICALLY QUALIFIED TO TEST SOLAR COLLECTORS IN ACCORDANCE WITH ASHRAE STANDARD 93-77: A SUMMARY REPORT** Final Report

William J. Niessing Nov. 1978 40 p  
(Contract EA-77-A-01-6010)  
(PB-289729/6; NBSIR-78-1535) Avail: NTIS HC A03/MF A01 CSCL 14B

The procedures used by ARI Foundation Inc. and the results of their evaluation are described. The laboratories evaluated as qualified to test solar collectors in accordance with American Society of Heating, Refrigerating and Air-Conditioning Engineers Standard 93-77 are listed.

GRA

**N79-20525#** NATO Committee on the Challenges of Modern Society, Brussels (Belgium).

**SOLAR ENERGY PILOT STUDY** Final Report

Oct. 1978 100 p Prepared by Maryland Univ., College Park  
(Contract EY-76-S-05-4908)

(PB-289380/8; NATO/CCMS-83; UMD-4908-13) Avail: NTIS HC A05/MF A01 CSCL 13A

The CCMS Solar Energy Pilot Study was established in 1973 with the objective of encouraging the cost-effective and practical application of solar energy to heating and cooling in residential, commercial, industrial, agricultural, and public buildings. The scope of the pilot study has been the exchange of information on: (1) national solar heating and cooling programs; (2) solar heating and cooling experiments, with emphasis on system performance data; and (3) specialized regional applications of solar heating and cooling. The various elements of this multilateral cooperative program are discussed.

GRA

**N79-20626#** Illinois Valley Economic Development Corp., Carlinville.

**SOLAR SPACE HEATERS FOR LOW-INCOME FAMILIES**

Roger Fenton and Patti Donahue Sep. 1978 29 p refs  
Sponsored by Illinois Inst. of Natural Resources.  
(PB-289244/6; ILLDOE-78/09) Avail: NTIS HC A03/MF A01 CSCL 13A

N79-20727

The publication is a manual designed to guide individuals in the construction and installation of a low-cost window-box solar collector. Included are explanations of solar collector fundamentals, lists of construction and installation materials and tools, step-by-step procedures for building and installing a unit and an extensive bibliography of information on home weatherization and solar energy use.

GRA

N79-20727# Syracuse Research Corp., N. Y.

**HEALTH EFFECTS ASSOCIATED WITH DIESEL EXHAUST EMISSIONS, LITERATURE REVIEW AND EVALUATION**

Joseph Santodonato, Dipak Basu, and Philip Howard Nov. 1978 185 p refs

(Contract EPA-68-02-2800)

(PB-289817/9; EPA-600/1-78-063)

Avail: NTIS

HC A08/MF A01 CSCL 06T

Engineering tests have shown a significant improvement in fuel economy in light duty vehicles equipped with diesel engines versus those equipped with gasoline engines. Automobile manufacturers are considering a major program for conversion to diesel engines in the automobile fleet by 1985. Available studies show rather large differences in emissions from diesel engine exhausts as opposed to gasoline engine exhaust. An assessment of the current state of knowledge regarding the health effects from diesel exhaust emissions, and the identification of major research needs, are important factors. In order to accomplish this objective, the following information on diesel emissions was reviewed: physical and chemical characteristics; biological effects in animals and man; epidemiologic studies; knowledge gaps; and research needs.

GRA

N79-20927# Brookhaven National Lab., Upton, N. Y.

**ECONOMIC IMPACTS OF A TRANSITION TO HIGHER OIL PRICES**

Raymond G. Tessmer, Jr., Steven C. Carhart, and William Marcuse Jun. 1978 63 p refs

(Contract EY-76-C-02-0016)

(BNL-50871) Avail: NTIS HC A04/MF A01

Economic impacts of sharply higher oil and gas prices in the eighties are estimated using a combination of optimization and input-output models. A 1985 base case is compared with a high case in which crude oil and crude natural gas are, respectively, 2.1 and 1.4 times as expensive as in the base case. Impacts examined include delivered energy prices and demands, resource consumption, emission levels and costs, aggregate and compositional changes in Gross National Product, balance of payments, output, employment, and sectoral prices. Methodology is developed for linking models in both quantity and price space for energy service - specific fuel demands. A set of energy demand elasticities is derived which is consistent between alternative 1985 cases and between the 1985 cases and an historical year (1967). A framework and methodology are also presented for allocating portions of the DOE conservation budget according to broad policy objectives and allocation rules.

Author

N79-20928 Committee of the Whole House on the State of the Union (U. S. House).

**AUTHORIZING APPROPRIATIONS TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**

Washington GPO 1979 237 p refs Rept. together with additional views to accompany H.R. 1786 from the Comm. on Sci. and Technol., 96th Congr., 1st Sess., 19 Mar. 1979

(H-Rept-96-52; GPO-41-646) Avail: US Capital, House Document Room

Increases and reductions in NASA's request for funding to support research and development, construction of facilities, and program management are justified in an analysis of H.R. 1786 which is recommended for passage.

A.R.H.

N79-21075# Ford Motor Co., Dearborn, Mich. Research Staff.

**EVALUATION OF CERAMICS FOR STATOR APPLICATION: GAS TURBINE ENGINE REPORT** Progress Report, 1 Feb. 1978 - 31 Jul. 1978

W. Trela and P. H. Havstad Nov. 1978 36 p refs Prepared for DOE

(Contract DEN-3-00019)

(NASA-CR-159533; DOE/NASA/0019-78/1) Avail: NTIS HC A03/MF A01 CSCL 21E

Current ceramic materials, component fabrication processes, and reliability prediction capability for ceramic stators in an automotive gas turbine engine environment are assessed. Simulated engine duty cycle testing of stators conducted at temperatures up to 1093 C is discussed. Materials evaluated are SiC and Si<sub>3</sub>N<sub>4</sub> fabricated from two near-net-shape processes: slip casting and injection molding. Stators for durability cycle evaluation and test specimens for material property characterization, and reliability prediction model prepared to predict stator performance in the simulated engine environment are considered. The status and description of the work performed for the reliability prediction modeling, stator fabrication, material property characterization, and ceramic stator evaluation efforts are reported. J.M.S.

N79-21167# National Bureau of Standards, Washington, D. C. **TEST PROCEDURES FOR THE DETERMINATION OF THE GROSS CALORIC VALUE OF REFUSE AND REFUSE-DERIVED-FUELS BY OXYGEN BOMB CALORIMETRY: SUMMARY OF THE 1977 FISCAL YEAR RESULTS** Interim Report, 1 Apr. - 30 Sep. 1977

D. R. Kirklin, D. J. Mitchell, J. Cohen, E. S. Domalski, and S. Abramowitz Dec. 1978 36 p refs Sponsored in part by DOE and EPA

(PB-290160/1; NBSIR-78-1494) Avail: NTIS HC A03/MF A01 CSCL 07D

Procedures used for coke and coal were modified to determine the gross caloric values (moisture and ash-free basis) for refuse derived from fuels provided by two manufacturers. The values obtained for one fuel ranged from 24.51 to 25.20 MJ kg (10539 to 10835 Btu lb) with a standard deviation of 0.8%. Values of the other product ranged from 21.93 to 22.16 MJ kg (9427 to 9528 Btu lb) with a standard deviation of 0.4%. Results of 23 laboratory samples are presented at various stages of sample preparation which were derived from single field samples from each of the two sources. Calorimetric results based on an equilibrated laboratory sample are presented along with some semi-quantitative spectrochemical results. The results indicate that the techniques of oxygen bomb calorimetry can be successfully applied to a non-homogeneous refuse stream after considerable processing to prepare a homogeneous refuse-derived fuel.

GRA

N79-21215 Notre Dame Univ., Ind. **CATALYTIC EFFECT OF Ni AND K<sub>2</sub>CO<sub>3</sub> IN THE GASIFICATION OF CARBON AND COAL** Ph.D. Thesis

Guillermo Leon GuzmanR 1979 216 p Avail: Univ. Microfilms Order No. 7908378

The catalytic effect of nickel and K<sub>2</sub>CO<sub>3</sub> on the gasification of activated carbon and Illinois Number 6 coal was studied at atmospheric pressure and temperatures between 500 to 927 C, using a Cahn RG electrobalance. Nickel was a very active catalyst in the gasification of activated carbon, producing CH<sub>4</sub> in hydrogasification and mainly CO<sub>2</sub> and CO in steam gasification. In coal, nickel exhibited very low activity, probably due to sulphur poisoning. The catalytic effect of K<sub>2</sub>CO<sub>3</sub> on the steam gasification of activated carbon and coal was investigated. K<sub>2</sub>CO<sub>3</sub> is a good catalyst in both carbon samples but its activity was less than the activity observed for nickel in activated carbon. Unlike nickel, K<sub>2</sub>CO<sub>3</sub> is not deactivated by the sulphur content of the coal and can be recovered from the remaining ashes. Dissert. Abstr.

N79-21217# National Aeronautics and Space Administration, Washington, D. C.

**DEPENDENCE OF THE POOR POINT OF DIESEL FUELS ON THE PROPERTIES OF THE INITIAL COMPONENTS**

V. M. Ostashov and S. A. Bobrovskiy Apr. 1979 8 p refs Transl. into English of 'Zavisimost' Temperatury Zastyvaniya Dizelnykh Topliv ot Svoystv Iskhodnykh Komponentov', Rept. no. 87 Moskovskiy Inst. Neftekhimicheskoy i Gasovoy Promshlennosti, Moscow, 1971 p 124-126 Transl. by Kanner (Leo) Associates, Redwood City, Calif.

(Contract NASw-3199)

(NASA-TM-75424) Avail: NTIS HC A02/MF A01 CSCL 21D

An analytical expression is obtained for the dependence of the pour point of diesel fuels on the pour point and weight relationship of the initial components. For determining the pour point of a multicomponent fuel mixture, it is assumed that the mixture of two components has the pour point of a separate equivalent component, then calculating the pour point of this equivalent component mixed with a third component, etc. Author

**N79-21223#** National Technical Information Service, Springfield, Va.

**SYNTHETIC FUELS: METHANE. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1970 - Jan. 1979**

Diane M. Cavagnaro Feb. 1979 269 p Supersedes NTIS/PS-78/0054  
(NTIS/PS-79/0030/1; NTIS/PS-78/0054). Avail: NTIS HC \$28.00/MF \$28.00 CSCL 21D

The production of methane is discussed in this bibliography containing worldwide citations. The reports pertain to the manufacturing processes, equipment used, performance, economics, and combustion technology. Many of the studies cover the production of methane from wastes, especially agricultural wastes. GRA

**N79-21224#** Battelle Columbus Labs., Ohio.

**PRELIMINARY ENVIRONMENTAL ASSESSMENT OF BIOMASS CONVERSION TO SYNTHETIC FUELS Report for Jul. 1978 - Dec. 1978**

S. T. DiNovo, W. E. Ballantyne, L. M. Curran, W. C. Baytos, and K. M. Duke Oct. 1978 366 p refs  
(Contract EPA-68-02-1323)  
(PB-289775/9; EPA-600/7-78-204) Avail: NTIS HC A16/MF A01 CSCL 21D

A preliminary evaluation of biomass production and conversion technologies, and their associated environmental consequences is presented. Five categories of biomass production were considered in detail. Thermochemical and biochemical technology were considered for conversion processes. Regionalized scenarios were prepared using commercial scale plants processing appropriate regionalized feedstock. Most processes use heterogeneous solid waste as a feed stock which are believed to pose more severe control requirements for emissions and effluents than other biomass feedstocks. The environmental and socio-economic effects of locating large conversion plants in rural environments need to be studied. GRA

**N79-21233#** Coast Guard, Washington, D.C. Merchant Marine Safety.

**LIQUEFIED NATURAL GAS SAFETY RESEARCH OVERVIEW Final Report**

Alan L. Schneider Dec. 1978 72 p refs Presented at the LNG Terminal and Safety Symp., San Diego, Calif., 12-13 Oct. 1978; sponsored by the Am. Gas Assoc. and the Cryogenic Soc. of Am.  
(AD-A063714) Avail: NTIS HC A04/MF A01 CSCL 21/4

Liquefied Natural Gas (LNG) is a growing factor in the United States energy supply situation, both for periods of high demand, peak shaving, and for daily supply (base load). Safety has been a major issue in its acceptance by the public, the government, and industry. Perhaps because of this, industry and government have undertaken programs of research, development, testing, and evaluation that are more extensive than those for most other new hazardous materials. This paper records the experimental and theoretical work performed with the goal of increasing LNG safety, and has been organized in fourteen divisions: land storage tank studies, rollover, dispersion from spills on land, land spill fire studies, land spill fire protection, ship studies, flameless explosion, dispersion from spills on water, underwater releases, water spill fire studies, vapor cloud deflagration, vapor cloud detonation, physical properties, and gelation. Examining the record of the LNG research effort leads inevitably to the conclusion that there is a basic understanding of the material, sufficient to design, operate, and regulate LNG transportation and storage.

Author (GRA)

**N79-21235#** National Inst. of Building Sciences, Washington, D. C. Building Economics and Regulatory Technology Div.

**SOLAR BUILDING REGULATORY STUDY, VOLUME 1 Final Report**

Nov. 1978 93 p Sponsored in part by NBS  
(Contract EA-77-A-01-6010)  
(PB-289823/7; NBS-GCR-78-141-1-Vol-1) Avail: NTIS HC A05/MF A01 CSCL 13A

The results of a project oriented toward obtaining the views of organizations representing diversified interests within the building community are documented. The need for a solar regulatory system, and the form such a system should take if indeed a solar regulatory system were recommended are discussed. GRA

**N79-21248#** Williston, McNeil and Associates, Lakewood, Colo. **A TIME DOMAIN SURVEY OF THE LOS ALAMOS REGION, NEW MEXICO**

Los Alamos, N. Mex. LASL Jan. 1979 51 p ref  
(Contract W-7405-eng-36)  
(LA-7657-MS) Avail: NTIS HC A04/MF A01

A time domain electromagnetic sounding survey of the region surrounding the city of Los Alamos, New Mexico was carried out. The results show that a linear through, trending northeast-southwest runs beneath the city. The southern boundary is somewhat to the south of the city, the northern boundary was not established. The geoelectric section consists of three layers and the total thickness of the section is in excess of 3,000 m. The resistivities of the second layer are as low as 2.5 ohms m. If the salinities are in the region of 7,000 ppm, the resistivities could indicate that water with a temperature of 150 C may be found at a depth of 3,000 m. Author

**N79-21309#** Biphase Energy Systems, Inc., Santa Monica, Calif. **DEMONSTRATION OF A ROTARY SEPARATOR FOR TWO-PHASE BRINE AND STEAM FLOWS Final Report**

Donald J. Cerini Jan. 1978 122 p refs  
(Contract EY-76-C-03-1228)  
(TID-28519) Avail: NTIS HC A08/MF A01

The application of a two-phase rotary separator for geothermal energy conversion was demonstrated. The system tested consisted of the major components of a total flow rotary separator/turbine conversion system. A nozzle converted the brine wellhead enthalpy to two-phase flow kinetic by impinging the nozzle flow tangentially on the inside of the separator. The flow was subjected to the high centrifugal force field in the separator. This caused the liquid phase to collect as a film on the separator drum with very little energy loss. The steam was allowed to flow radially inward to the central steam discharge. Potable water was obtained by condensing the steam exhaust. The brine collection system converted the liquid film kinetic energy to static pressure head. Application of the rotary separator/turbine to a two-stage flash steam system showed a calculated power increase of 18%. Author

**N79-21310#** Stanford Univ., Calif.

**INSULATING WALL BOUNDARY LAYER IN A FARADAY MHD GENERATOR**

Roy R. Rankin Apr. 1978 129 p refs  
(Contract EX-76-C-01-2341)  
(FE-23417) Avail: NTIS HC A07/MF A01

Experimental and analytical investigation was undertaken of the insulating wall boundary layer in a Faraday MHD generator. Insulating wall boundary layers show that modifications due to (MHD) effects have significant influence on the insulating wall friction and heat transfer in Faraday MHD generators. Modified flow (Hartmann Flow) is evidenced by an alteration of the velocity profile, due to the variation of the  $J \times B$  force across the channel in the magnetic field direction. The nonuniform current distribution is related to variations in both the velocity and the electrical conductivity across the channel. The analytic model involved computerized solution, using finite difference techniques, of the momentum, energy, and electrical equations, including MHD effects for the turbulent insulating wall boundary layer. The turbulence model used, was the mixing length theory which was modified to include turbulence damping. Variable, equilibrium properties were employed producing a coupling between the

N79-21334

momentum, energy, and electrical equations resulting in extended Hartmann flow. The experimental study consisted of the measurement of the velocity profile at the center of the insulating wall in an MHD generator using a laser anemometer. L.P.

**N79-21334\***# Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.

**LASER POWER CONVERSION SYSTEM ANALYSIS, VOLUME 1** Final Report, 26 Sep. 1977 - 26 Sep. 1978

W. S. Jones, L. L. Morgan, J. B. Forsyth, and J. P. Skratt  
15 Mar. 1979 109 p refs  
(Contract NAS3-21137)

(NASA-CR-159523-Vol-1; LMSC-D673466-Vol-1) Avail: NTIS HC A06/MF A01 CSCL 20E

The orbit-to-orbit laser energy conversion system analysis established a mission model of satellites with various orbital parameters and average electrical power requirements ranging from 1 to 300 kW. The system analysis evaluated various conversion techniques, power system deployment parameters, power system electrical supplies and other critical supplies and other critical subsystems relative to various combinations of the mission model. The analysis show that the laser power system would not be competitive with current satellite power systems from weight, cost and development risk standpoints. Author

**N79-21335\***# Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.

**LASER POWER CONVERSION SYSTEM ANALYSIS, VOLUME 2** Final Report, 26 Sep. 1977 - 26 Sep. 1978

W. S. Jones, L. L. Morgan, J. B. Forsyth, and J. P. Skratt  
15 Mar. 1979 112 p refs  
(Contract NAS3-21137)

(NASA-CR-159523-Vol-2; LMSC-D673466-Vol-2) Avail: NTIS HC A06/MF A01 CSCL 20E

The orbit-to-ground laser power conversion system analysis investigated the feasibility and cost effectiveness of converting solar energy into laser energy in space, and transmitting the laser energy to earth for conversion to electrical energy. The analysis included space laser systems with electrical outputs on the ground ranging from 100 to 10,000 MW. The space laser power system was shown to be feasible and a viable alternate to the microwave solar power satellite. The narrow laser beam provides many options and alternatives not attainable with a microwave beam. Author

**N79-21390\***# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. **A LOW COST HIGH TEMPERATURE SUN TRACKING SOLAR ENERGY COLLECTOR**

Gerald S. Perkins In NASA. Goddard Space Flight Center  
The 11th Aerospace Mech. Symp. 28 Apr. 1977 p 163-175

(Contract NAS7-100)

Avail: NTIS HC A11/MF A01 CSCL 20K

The design and economic evaluation of a low cost high temperature two-axis sun tracking solar energy collector is described. The collector design was specifically intended for solar energy use with the freedom of motion about its two control axes limited only to the amplitude required to track the sun. An examination of the performance criteria required in order to track the sun and perform the desired solar energy conversion was used as the starting point and guide to the design. This factor, along with its general configuration and structural aspect ratios, was the significant contributor to achieving low cost. The unique mechanical design allowed the control system to counter wide tolerances specified for the fabrication of the azimuth frame and to perform within a small tracking error. J.A.M.

**N79-21392\***# Aerospatiale Etablissement des Mureaux (France). **DEVELOPMENT OF A SATELLITE FLYWHEEL FAMILY OPERATING ON ONE ACTIVE AXIS MAGNETIC BEARING**

Pierre C. Poubeau In NASA. Goddard Space Flight Center  
The 11th Aerospace Mech. Symp. 28 Apr. 1977 p 185-201

Avail: NTIS HC A11/MF A01 CSCL 20K

Since the samarium-cobalt magnets were available at industrial level, new possibilities appeared in the area of magnetic bearings with the radial passive centering and axial control of the rotor position. Magnetic bearings of this type on which a wide effort was made towards the optimization for satellite flywheel applications are described. Also, the momentum and reaction wheels were considered. This work was extended to the kinetic storage of energy for satellites. J.A.M.

**N79-21406\***# Southwest Research Inst., San Antonio, Tex. Dept. of Engine and Vehicle Research.

**SINGLE-CYLINDER DIESEL ENGINE TESTS WITH UNSTABILIZED WATER-IN-FUEL EMULSIONS** Final Report, Jan. 1977 - Jun. 1977

J. O. Storment and C. W. Coon Aug. 1978 89 p refs  
(Contract DOT-TSC-920)  
(AD-A062751; USCG-D-13-78; TSC-USCG-77-4) Avail: NTIS HC A05/MF A01 CSCL 21/4

A single-cylinder, four-stroke cycle diesel engine was operated on unstabilized water-in-fuel emulsions. Two prototype devices were used to produce the emulsions on-line with the engine. More than 350 test points were run with baseline diesel fuel and emulsified water-in-fuel. Water content of the emulsified fuel varied from about 2% to 23% by volume. Statistically significant decreases in fuel consumption, ranging from 1.2% to 5.1% were obtained with emulsified fuels in 20 out of 36 test conditions. An increase of 2.5% was measured at one condition only. Use of the emulsified fuels decreased oxides of nitrogen by up to about 60% and Bosch smoke numbers by up to almost 70%, whereas unburned hydrocarbons increased up to over 130%. Carbon monoxide changes with emulsified fuel varied from a decrease of 52% to an increase of over 170%, depending on engine speed and power, and water content of the fuel. No problems were encountered in engine operation at any test condition with the water-in-fuel emulsions. Author (GRA)

**N79-21429\***# Rocketdyne, Canoga Park, Calif.

**HYDROGEN EMBRITTLEMENT AND ITS CONTROL IN HYDROGEN-FUELED ENGINE SYSTEMS**

V. T. Chandler In NASA. Langley Res. Center Recent Advan. in Structures for Hypersonic Flight, Pt. 1. 1978 p 195-249 refs

(Contract NAS8-27980)  
Avail: NTIS HC A23/MF A01 CSCL 20K

The nature of hydrogen embrittlement by high pressure gaseous hydrogen is described and methods of designing SSME gaseous hydrogen systems, including techniques of hydrogen embrittlement prevention, are discussed. The effects of gaseous hydrogen environments are emphasized. Results of extensive investigations of gaseous hydrogen environments on metals conducted under the SSME program are presented. J.M.S.

**N79-21523\***# GeoEnergy Corp., Las Vegas, Nev.

**AN ASSESSMENT OF SUBSURFACE SALT WATER DISPOSAL EXPERIENCE ON THE TEXAS AND LOUISIANA GULF COAST FOR APPLICATION TO DISPOSAL OF SALT WATER FROM GEOPRESURRED GEOTHERMAL WELLS**  
C. F. Knutson and C. R. Boardman 4 Aug. 1978 78 p refs  
(Contract EY-77-C-08-1531)

(INVO/1531-2) Avail: NTIS HC A05/MF A01  
The primary problems with respect to salt water disposal in the Gulf Coast area in general were determined from literature and current experience. High rate salt water disposal well data obtained for 8 specific counties in Texas and 10 parishes in Louisiana. Salt water disposal data and operating experience information were obtained from major gas and oil companies operating in the areas of interest, from DOE's strategic petroleum reserve program, and from an industrial waste engineering firm based in Houston. A prognosis is provided for the subsurface disposal of salt water at rates equal to or greater than approximately 3,000 bbls/day or 1,000,000 bbls/yr per well. Gulf Coast geology is reviewed and the mechanical, chemical, environmental, and legal aspects of salt water disposal are examined. A.R.H.

**N79-21530#** Massachusetts Inst. of Tech., Cambridge. Dept. of Earth and Planetary Sciences.

**MICROCRACK TECHNOLOGY FOR GEOTHERMAL EXPLORATION AND ASSESSMENT Final Report, 1 Mar. 1978 - 31 Aug. 1978**

Gene Simmons 31 Aug. 1978 297 p refs  
 (Grants NSF AER-75-09588; NSF DAR-75-09588-A01)  
 (PB-290173/4; NSF/RA-780302) Avail: NTIS  
 HC A13/MF A01 CSCL 081

Repeated fracturing and fracture sealing were observed in core samples from six geothermal areas. Both fracture porosity and morphology vary widely. The minerals that seal fractures show significant temporal variations. Water-rock reactions and alteration often produce low density or hydrous phases that further seal and block cracks. Such parameters as hydraulic permeability and electrical conductivity that influence the geologic environment or serve as geothermal indicators are dependent on the fracture state of the rock. The microfractures from these geothermal areas have several distinctive characteristics which are explained. The microfractures in geothermal rocks reflect the dynamics of the geothermal system. The results of this investigation are applicable to several problems encountered in the exploration for geothermal areas and evaluation of the reservoir: (1) locating the geothermal areas; (2) interpretation of electrical surveys; and (3) prediction of reservoir characteristics and reservoir behavior during exploration.

GRA

**N79-21538#** National Aeronautics and Space Administration, Washington, D. C.

**SATELLITE POWER SYSTEM: CONCEPT DEVELOPMENT AND EVALUATION PROGRAM, REFERENCE SYSTEM REPORT**

Jan. 1979 321 p refs Prepared in cooperation with DOE, Washington, D. C.  
 (NASA-TM-3762; DOE/ER-0023) Avail: NTIS  
 HC A14/MF A01 CSCL 10B

The Satellite Power System (SPS) Reference System is discussed and the technical and operational information required in support of environmental, socioeconomic, and comparative assessment studies are emphasized. The reference System concept features a gallium-aluminum-arsenide, and silicon solar cell options. Other aspects of an SPS are the construction of bases in space, launch and mission control bases on earth, and fleets of various transportation vehicles to support the construction and maintenance operations of the satellites. M.M.M.

**N79-21541** South Carolina Univ., Columbia.

**A STUDY OF THE EFFECTIVE RESISTANCE OF THE DIFFUSED LAYER AND ITS EFFECT ON SOLAR CELL PERFORMANCE Ph.D. Thesis**

Yingsheng Tung 1978 123 p  
 Avail: Univ. Microfilms Order No. 7907638

The series resistance associated with the solar cell was proven to be a limiting factor on the conversion efficiency. The contribution from the diffused layer to the total series resistance is analyzed using a numerical method. It is found that the relationship between the current and the voltage in the diffused layer is nonlinear; consequently, the electrical behavior of this layer can not be described by a resistance of constant value. Another approach for synthesizing the solar cell design is proposed using unit fields as building blocks. Since the total power output from a cell can be derived from that of the constituent unit fields, the performance of the cell as a whole can be predicted once the current and voltage characteristics of the unit field are known. A procedure is described which enables one to accomplish this through the construction of the I-V curves of each unit field. Dissert. Abstr.

**N79-21543#** Agricultural and Technical Coll. of North Carolina, Greensboro. Department of Electrical Engineering.

**MATERIAL GROWTH AND CHARACTERIZATION DIRECTED TOWARD IMPROVING III-V HETEROJUNCTION SOLAR CELLS Annual Report, 1 Feb. 1978 - 31 Jan. 1979**

Elias K. Stefanakos, Winser E. Alexander, Ward Collis, and Ali Abul-Fadl 31 Jan. 1979 88 p refs  
 (Grant Nsg-1390)  
 (NASA-CR-158476) Avail: NTIS HC A05/MF A01 CSCL 10A

In addition to the existing materials growth laboratory, the photolithographic facility and the device testing facility were completed. The majority of equipment for data acquisition, solar cell testing, materials growth and device characterization were received and are being put into operation. In the research part of the program, GaAs and GaAlAs layers were grown reproducibly on GaAs substrates. These grown layers were characterized as to surface morphology, thickness and thickness uniformity. The liquid phase epitaxial growth process was used to fabricate p-n junctions in  $[\text{Ga}(1-x)\text{Al}x]\text{As}$ . Sequential deposition of two alloy layers was accomplished and detailed analysis of the effect of substrate quality and dopant on the GaAlAs layer quality is presented. Finally, solar cell structures were formed by growing a thin p-GaAlAs layer upon an epitaxial n-GaAlAs layer. The energy gap corresponding to the long wavelength cutoff of the spectral response characteristic was 1.51-1.63 eV. Theoretical calculations of the spectral response were matched to the measured response.

**N79-21545#** Boeing Engineering and Construction, Seattle, Wash.

**FEASIBILITY STUDY OF SOLAR DOME ENCAPSULATION OF PHOTOVOLTAIC ARRAYS Final Report**

Dec. 1978 175 p refs Sponsored by NASA Prepared for DOE and JPL  
 (Contract JPL-954833)  
 (NASA-CR-158368; DOE/JPL-954833-78/1) Avail: NTIS  
 HC A08/MF A01 CSCL 10A

The technical and economic advantages of using air-supported plastic enclosures to protect flat plate photovoltaic arrays are described. Conceptual designs for a fixed, latitude-tilt array and a fully tracking array were defined. Detailed wind loads and strength analyses were performed for the fixed array. Detailed thermal and power output analyses provided array performance for typical seasonal and extreme temperature conditions. Costs of each design as used in a 200 MWe central power station were defined from manufacturing and material cost estimates. The capital cost and cost of energy for the enclosed fixed-tilt array were lower than for the enclosed tracking array. The enclosed fixed-tilt array capital investment was 38% less, and the leveled bus bar energy cost was 26% less than costs for a conventional, glass-encapsulated array design. The predicted energy cost for the enclosed fixed array was 79 mills/kW-h for direct current delivered to the power conditioning units. L.P.

**N79-21547#** Rasar Associates, Inc., Sunnyvale, Calif.

**POWER COUPLING ALTERNATIVES FOR THE NEP THERMIONIC POWER SYSTEM Final Report**

M. L. Manda, E. J. Britt, and G. O. Fitzpatrick Dec. 1978 64 p refs Prepared for JPL  
 (Contracts NAS7-100; JPL-955121)  
 (NASA-CR-158372; NSR-7-1) Avail: NTIS HC A04/MF A01

Three output power coupling methods which can eliminate the high temperature insulator from the Nuclear Electric Propulsion (NEP) power system are described and estimates of their effects on the NEP system masses and cooling requirements are presented. Nominal 400 kW<sub>e</sub> power systems using push-pull and flux reset inductive output coupling are shown to have specific masses of 22.2 kg/kW<sub>e</sub> and 18.8 kg/kW<sub>e</sub>, respectively. Series connected heat pipe systems, which use the heat pipe-to-heat pipe resistance to isolate converters on adjacent heat pipes, are shown to have specific masses 0.5 to 1.4 kg/kW<sub>e</sub> lower than the NEP baseline system. Increasing the number and temperature of the heat pipes in the system without changing the electric output reduces the calculated system specific mass only slightly, whereas increasing the output power significantly reduces the specific mass. Estimates of cooling requirements indicate that 11-45 sq m of power conditioning radiator are needed. A possible location for the power conditioning radiator may be in the present location of the kapton sputter shield. M.M.M.

N79-21548

**N79-21548\***# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  **THERMAL POWER SYSTEMS SMALL POWER SYSTEMS APPLICATIONS PROJECT. DECISION ANALYSIS FOR EVALUATING AND RANKING SMALL SOLAR THERMAL POWER SYSTEM TECHNOLOGIES. VOLUME 1: A BRIEF INTRODUCTION TO MULTIATTRIBUTE DECISION ANALYSIS**

A. Feinberg and R. F. Miles, Jr. 1 Jun. 1978 30 p refs  
Prepared for DOE  
(Contract NAS7-100)  
(NASA-CR-158425; DOE/JPL-1060-15; JPL-Pub-79-12-Vol-1;  
Rept-5103-47-Vol-1) Avail: NTIS HC A03/MF A01 CSCL 10A

The principal concepts of the Keeney and Raiffa approach to multiattribute decision analysis are described. Topics discussed include the concepts of decision alternatives, outcomes, objectives, attributes and their states, attribute utility functions, and the necessary independence properties for the attribute states to be aggregated into a numerical representation of the preferences of the decision maker for the outcomes and decision alternatives.

L.P.

**N79-21549\***# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**EVALUATION OF MOSTAS COMPUTER CODE FOR PREDICTING DYNAMIC LOADS IN TWO BLADED WIND TURBINES**

K. R. V. Kaza (Toledo Univ.), D. C. Janetzke, and T. L. Sullivan 1979 21 p refs Presented at AIAA/ASCE/AHS 20th Structures, Structural Dynamics and Mater. Conf., St. Louis, Mo. 4-6 Apr. 1979

(Contract E(49-26)-1028)

(NASA-TM-79101; DOE/NASA/1028-72/2; E-9925) Avail: NTIS HC A02/MF A01 CSCL 10B

Calculated dynamic blade loads were compared with measured loads over a range of yaw stiffnesses of the DOE/NASA Mod-O wind turbine to evaluate the performance of two versions of the MOSTAS computer code. The first version uses a time-averaged coefficient approximation in conjunction with a multi-blade coordinate transformation for two bladed rotors to solve the equations of motion by standard eigenanalysis. The second version accounts for periodic coefficients while solving the equations by a time history integration. A hypothetical three-degree of freedom dynamic model was investigated. The exact equations of motion of this model were solved using the Floquet-Lipunov method. The equations with time-averaged coefficients were solved by standard eigenanalysis.

L.P.

**N79-21550\***# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**THE ROLE OF THERMAL ENERGY STORAGE IN INDUSTRIAL ENERGY CONSERVATION**

Rudolph A. Duscha and William J. Masica 1979 13 p refs Presented at a Conf. on Ind. Energy Conserv. Technol. and Exhibition, Houston, Tex., 22-25 Apr. 1979; sponsored by DOE and the Texas Ind. Comm.

(Contract EC-77-A-31-1034)

(NASA-TM-79122; DOE/NASA/1034-79/1; E-9957) Avail: NTIS HC A02/MF A01 CSCL 10C

Thermal Energy Storage for Industrial Applications is a major thrust of the Department of Energy's Thermal Energy Storage Program. Utilizing Thermal Energy Storage (TES) with process or reject heat recovery systems is shown to be extremely beneficial for several applications. Recent system studies resulting from contracts awarded by the Department of Energy (DOE) identified four especially significant industries where TES appears attractive - food processing, paper and pulp, iron and steel, and cement. Potential annual fuel savings with large scale implementation of near term TES systems for these industries is over 9,000,000 bbl of oil. This savings is due to recuperation and storage in the food processing industry, direct fuel substitution in the paper and pulp industry and reduction in electric utility peak fuel use through implant production of electricity from utilization of reject heat in the steel and cement industries.

Author

**N79-21551\***# ECON, Inc., Princeton, N. J.

**ASSESSMENT OF ECONOMIC FACTORS AFFECTING THE SATELLITE POWER SYSTEM. VOLUME 1: SYSTEM COST FACTORS Final Report**

George A. Hazelrigg, Jr. 15 Dec. 1978 175 p refs  
(Contract NAS8-33002)

(NASA-CR-161185; Econ-78-147-1) Avail: NTIS HC A08/MF A01 CSCL 10B

The factors relevant to SPS costing and selection of preferred SPS satellite configurations were studied. The issues discussed are: (1) consideration of economic factors in the SPS system that relate to selection of SPS satellite configuration; (2) analysis of the proper rate of interest for use in SPS system definition studies; and (3) the impacts of differential inflation on SPS system definition costing procedures. A cost-risk comparison of the SPS satellite configurations showed a significant difference in the levelized cost of power from them. It is concluded, that this difference is the result more of differences in the procedures for assessing costs rather than in the satellite technologies required or of any advantages of one satellite configuration over the other. Analysis of the proper rate of interest for use in SPS system is 4 percent. The major item of differential inflation to be expected over this period of time is the real cost of labor. This cost is likely to double between today and the period of SPS construction.

M.M.M.

**N79-21552\***# Little (Arthur D.), Inc., Cambridge, Mass.

**ASSESSMENT OF ECONOMIC FACTORS AFFECTING THE SATELLITE POWER SYSTEM. VOLUME 2: THE SYSTEMS IMPLICATIONS OF RECTENNA SITING ISSUES Final Report**

Philip K. Chapman, Beverly J. Bugos, Katinka I. Csigi, Peter E. Glaser, Gerald R. Schimke, and Richard G. Thomas 8 Mar. 1979 66 p refs Prepared for ECON, Inc., Princeton, N. J.  
(Contract NAS8-33002)

(NASA-CR-161186) Avail: NTIS HC A04/MF A01 CSCL 10B

The feasibility was evaluated of finding potential sites for Solar Power Satellite (SPS) receiving antennas (rectennas) in the continental United States, in sufficient numbers to permit the SPS to make a major contribution to U.S. generating facilities, and to give statistical validity to an assessment of the characteristics of such sites and their implications for the design of the SPS system. It is found that the cost-optimum power output of the SPS does not depend on the particular value assigned to the cost per unit area of a rectenna and its site, as long as it is independent of rectenna area. Many characteristics of the sites chosen affect the optimum design of the rectenna itself.

Author

**N79-21554\***# Honeywell, Inc., Minneapolis, Minn.

**ACTIVE HEAT EXCHANGE SYSTEM DEVELOPMENT FOR LATENT HEAT THERMAL ENERGY STORAGE**

R. T. LeFrois, G. R. Knowles, A. K. Mathur, and J. Budimir Feb. 1979 122 p refs

(Contracts DEN-3-38; EC-77-A-31-1034)

(NASA-CR-159479; HI-78336; DOE/NASA/0038-79/1) Avail: NTIS HC A06/MF A01 CSCL 10A

Active heat exchange concepts for use with thermal energy storage systems in the temperature range of 250 C to 350 C, using the heat of fusion of molten salts for storing thermal energy are described. Salt mixtures that freeze and melt in appropriate ranges are identified and are evaluated for physico-chemical, economic, corrosive and safety characteristics. Eight active heat exchange concepts for heat transfer during solidification are conceived and conceptually designed for use with selected storage media. The concepts are analyzed for their scalability, maintenance, safety, technological development and costs. A model for estimating and scaling storage system costs is developed and is used for economic evaluation of salt mixtures and heat exchange concepts for a large scale application. The importance of comparing salts and heat exchange concepts on a total system cost basis, rather than the component cost basis alone, is pointed out. The heat exchange concepts were sized and compared for 6.5 MPa/281 C steam conditions and a 1000 MW(t) heat rate for six hours. A cost sensitivity analysis for other design conditions is also carried out.

L.P.

**N79-21555#** California Univ., Berkeley. Lawrence Berkeley Lab.

**A COMPUTERIZED REPORTING AND MONITORING SYSTEM FOR GEOTHERMAL ENERGY DEVELOPMENT**

S. L. Phillips, M. Tavana, K. Leung, M. Steyer, W. A. Palen, and S. R. Schwartz Dec. 1978 62 p refs  
(Contract W-7405-eng-48)

(LBL-8483) Avail: NTIS HC A04/MF A01

It is proposed that the on-going compilation and critical evaluation of data be expanded to include a computerized system for monitoring and reporting the development of geothermal resources from the discovery phase to power on-line. Data would be covered which is site-specific and therefore unique to the geothermal area. Computer printouts are to contain a listing of each geothermal site which will be classified according to the status of development for producing electrical power. The result of the work will consist of a report containing a description of the data at each site and recommendations for additional data needs in technological, economic, or institutional areas. The computerized system will allow for ease in updating and remote accessing by off-site users.

Author

**N79-21556#** Westinghouse Research and Development Center, Pittsburgh, Pa.

**THIN FILM BATTERY/FUEL CELL POWER GENERATING SYSTEM** Final Report, Apr. 1978 - Apr. 1978

31 Mar. 1978 226 p refs  
(Contract EY-76-C-03-1197)  
(CONS/1197-9) Avail: NTIS HC A11/MF A01

A rare-earth chromite was identified and synthesized by RF-sputtering. It was tested for resistivity, thermal expansion and inertness in contact with yttria-stabilized zirconia, and was used as an interconnection material. Films of these interconnection materials were successfully deposited onto stabilized zirconia tubes by electrochemical vapor deposition. This technique was used to fabricate such films in building fuel cell stacks. Tin-doped indium oxide and antimony-doped tin oxide air electrode current collector materials were successfully chemically vapor deposited, as thin films, onto zirconia tubes. An in-house extrusion technology for porous calcia-stabilized zirconia tubes were developed and used to provide suitable support tubes for component combination samples, unit cell and cell stack sample preparation. L.P.

**N79-21557#** Battelle Pacific Northwest Labs., Richland, Wash.  
**DEVELOPMENT, CHARACTERIZATION AND EVALUATION OF MATERIALS FOR OPEN CYCLE MHD**

J. Lambert Bates, D. D. Marchant, and J. L. Daniel Aug. 1978 44 p refs  
(Contract EY-76-C-06-1830)

(PNL-2004-8) Avail: NTIS HC A03/MF A01

Progress in the development of high temperature ceramics for open cycle, coal-fired MHD power generators is reported. Emphasis is placed on electrode and insulator materials. Specific areas covered include: (1) electrochemical effects of alkali seed/coal slags on electrodes and insulators; (2) characterization of material from Westinghouse MHD proof tests; (3) thermal diffusivity/conductivity; (4) electrical conductivity of oxide insulators; and (5) materials development.

J.M.S.

**N79-21558#** Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Energy Systems Div.

**DEVELOPMENT, TESTING AND EVALUATION OF MHD MATERIALS AND COMPONENT DESIGNS** Quarterly Report, Jan. - Mar. 1978

John W. Sadler, Jeff Bein, David L. Black, Raymond Calvo, Laurence H. Cadoff (Westinghouse Res. and Develop. Center), James A. Dilmore (Westinghouse Res. and Develop. Center), Gary E. Driesen, Alfred G. Eggers, Edsel W. Franti, and Edgar L. Kochka May 1978 160 p refs  
(Contract EX-76-C-01-2248)

(FE-2248-19) Avail: NTIS HC A08/MF A01

Electrodes were evaluated for both clean and coal fired environments. Electrochemical screening tests in simulated liquid slags, conducted to provide additional information on the chemistry, mechanisms, and kinetics of electrode/slag reactions

are described. The U-O2 post-test materials characterization provided the basis for the selection of LaCrO<sub>3</sub> - based electrode materials with compliant Ni-mesh attachments for the U-O2 phase 3 electrode walls. Materials developed and detail design activities in support of the U-O2 phase 3 module were continued, and U-O2 phase 3 electrode sub-assemblies were prepared. A.R.H.

**N79-21559#** Allied Chemical Corp., Idaho Falls, Idaho. Chemical Programs - Operations Office.

**LIQUID-FLUIDIZED-BED HEAT EXCHANGER FLOW DISTRIBUTION MODELS**

L. T. Cole and C. A. Allen Jan. 1979 20 p refs  
(Contract EY-76-C-07-1540)

(ICP-1151) Avail: NTIS HC A02/MF A01

Liquid-fluidized-bed shell-and-tube heat exchangers for geothermal applications are considered. Sand fluidized by geothermal water on the shell side prevents scaling and increases heat transfer coefficients over conventional heat exchangers. Tests conducted on two instrumented fluidized-bed heat exchanger models, constructed primarily of plexiglass, which differ in tube bundle orientation are described. Plexiglass construction allowed visual observation of flow patterns. The vertical model proved to have more uniform flow distribution and higher heat transfer coefficients than the horizontal model. The horizontal heat exchanger experienced piling on top of the tubes and areas of poor fluidization existed in the bed. Geometric considerations show that a horizontal design is more conducive to large flow rates than a vertical design. New design concepts for both vertical and horizontal assemblies and recommendations for further development work are presented.

J.M.S.

**N79-21560#** Avco-Everett Research Lab., Mass.

**ENGINEERING TEST FACILITY CONCEPTUAL DESIGN, PART 1** Final Report

Jun. 1978 581 p  
(Contract EF-77-C-01-2614)

(FE-2614-2-Pt-1) Avail: NTIS HC A24/MF A01

The final document reporting material and information developed in the ETF (Engineering Test Facility) Conceptual Design Activity of the Department of Energy is presented. The specific ETF reference system design recommended in the previous preliminary ETF conceptual Design Document of December 1977 is reported. The major design goals of the EFT are: (1) to provide for demonstration of long duration of a complete combined MHD (magnetohydrodynamic)/steam power system of pilot scale with coal as the primary fuel source; (2) to provide for testing and evaluation of the overall system, subsystem and components performance, controls and interactions, and to identify and resolve critical problem areas; and (3) to provide design information and the necessary engineering base and confidence for subsequent commercialization of open cycle MHD power generation.

G.Y.

**N79-21561#** Avco-Everett Research Lab., Mass.

**ENGINEERING TEST FACILITY CONCEPTUAL DESIGN, PART 2** Final Report

Jun. 1978 486 p refs  
(Contract EF-77-C-01-2614)

(FE-2614-2-Pt-2) Avail: NTIS HC A21/MF A01

Part 2 of a two part final document is presented and reports on materials and information developed in the ETF (Engineering test Facility) Design Activity of the Department of Energy. The ETF goals are to design, operate and evaluate a complete combined MHD (magnetohydrodynamic)/steam power system of pilot plant scale with coal as the primary fuel source. Part 2 discusses the steam plant, instrumentation and control, plant layout, maintenance and service, buildings and structures, and site and site development.

G.Y.

**N79-21562#** Oak Ridge National Lab., Tenn.

**TRANSPORTATION ENERGY CONSERVATION DATA BOOK, EDITION 3**

D. B. Shonka, ed. Feb. 1979 555 p refs  
(Contract W-7405-eng-26)

(ORNL-5493) Avail: NTIS HC A24/MF A01

## N79-21563

All major modes of transportation are represented: highway, air, rail, marine, and pipeline. Various aspects of the transportation sector discussed: (1) modal characteristics, (2) current energy use, efficiency and conservation, (3) projections of modal energy use, (4) impact of government activities, (5) supply and cost of energy, and (6) general demographic and economic characteristics. More than 400 tables and figures show the following transportation stock and use statistics: number of vehicles, vehicle miles traveled, passenger-miles and freight ton-miles, fleet characteristics, household automobile ownership, size of mix of automobiles, vehicle travel characteristics, and commuting patterns. Energy characteristics presented include energy use by fuel source and transportation mode, energy intensity figures by mode, indirect energy use, production as a percent of consumption, imports as a percent of domestic production, energy prices from the wellhead to the retail outlet, and alternative fuels. A.R.H.

**N79-21563#** AiResearch Mfg. Co., Torrance, Calif.  
**WAYSIDE ENERGY STORAGE SUMMARY. VOLUME 1: SUMMARY** Final Report, May 1977 - Jun. 1978  
L. J. Lawson and L. M. Cook Feb. 1979 78 p refs 2 Vol. (Contract DOT-TSC-1349-1)  
(DOT-TSC-FRA-79-7-1-Vol-1; FRA/ORD-78-1-Vol-1) Avail: NTIS HC A05/MF A01

An in-depth application study was conducted to determine the practicality and viability of using large wayside flywheels to recuperate braking energy from freight trains on long downgrades. The study examined the route structures of nine U.S. railroads and identified various wayside energy storage system (WEES) configurations. The optimum means voltage ac catenary from either regenerative electric locomotives or modified dual-mode (diesel-electric/electric) locomotives. The application of WEES was analyzed for four specific routes of typical U.S. railroads. These routes and the annual returns on investment resulting from WEES deployment on existing railroads were as follows: Atchinson, Topeka, and Santa Fe (Los Angeles to Belen), 27.1 percent; Black Mesa and Lake Powell, 17.3 percent; Conrail (Pittsburgh to Harrisburg), 22.0 percent; Union Pacific (Los Angeles to Salt Lake City) 20.2 percent. L.S.

**N79-21564#** Brookhaven National Lab., Upton, N. Y. Economic Analysis Div.  
**THE BROOKHAVEN BUILDINGS ENERGY CONSERVATION OPTIMIZATION MODEL**  
Steven C. Carhart, Shirish S. Mulherkar, and Yasuko Sanborn Jan. 1978 85 p refs (Contract EY-76-C-02-0016)  
(BNL-50828) Avail: NTIS HC A05/MF A01

The Brookhaven Buildings Energy Conservation Optimization Model is a linear programming representation of energy use in buildings. Starting with engineering and economic data on cost and performance of energy technologies used in buildings, including both conversion devices (such as heat pumps) and structural improvements, the model constructs alternative flows for energy through the technologies to meet demands for space heating, air conditioning, thermal applications, and electric lighting and appliances. Alternative paths have different costs and efficiencies. Within constraints such as total demand for energy services, retirement of existing buildings, seasonal operation of certain devices, and others, the model calculates an optimal configuration of energy technologies in buildings. Author

**N79-21565#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.  
**THE 1977 GODDARD SPACE FLIGHT CENTER BATTERY WORKSHOP**  
1977 579 p Workshop held at Greenbelt, Md., 15-17 Nov. 1977  
(NASA-CP-2041) Avail: NTIS HC A25/MF A01 CSCL 10C

The papers presented were derived from transcripts taken at the Tenth Annual Battery Workshop held at the Goddard Space Flight Center, November 15-17, 1977. The Workshop was attended by manufacturers, users, and government representatives interested in the latest results of testing, analysis, and development of the sealed nickel cadmium cell system. The

purpose of the Workshop was to share flight and test experience, stimulate discussion on problem areas, and to review the latest technology improvements.

**N79-21571#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.  
**SYNCHRONOUS METEOROLOGICAL AND GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITES BATTERY AND POWER SYSTEM DESIGN**  
Dave A. Baer and Walter J. Schedler (Natl. Environ. Satellite Serv., Suitland, Md.) In its The 1977 Goddard Space Flight Center Battery Workshop 1977 p 69-79

Avail: NTIS HC A25/MF A01 CSCL 10C  
The battery was a three ampere hour nickel cadmium prismatic cell. The battery consists of 20 cells connected in series and there were two batteries per spacecraft. The battery operations (voltage and temperature) that the spacecraft sees during a normal operational day are discussed. G.Y.

**N79-21574#** National Aeronautics and Space Administration, Washington, D. C.  
**NASA'S OAST PROGRAM: AN OVERVIEW**  
Lee Holcomb In NASA. Goddard Space Flight Center The 1977 Goddard Space Flight Center Battery Workshop 1977 p 111-118

Avail: NTIS HC A25/MF A01 CSCL 10C  
The program was split into four areas which include: high energy density, long life batteries; low cost high capacity battery application; very high energy density batteries; and electrochemical research and technology program. Outlines are presented which show the approaches used and the accomplishments of each program area. G.Y.

**N79-21575#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. EFFORT OF THE JET PROPULSION LABORATORY  
Sam Bogner In NASA. Goddard Space Flight Center The 1977 Goddard Space Flight Center Battery Workshop 1977 p 119-132 Sponsored by NASA

Avail: NTIS HC A25/MF A01 CSCL 10C  
A discussion is presented which gives an overview of the research and technological areas on nickel cadmium batteries at the Jet Propulsion Laboratory. Some of the topics covered include: goals; failure modes and mechanisms; factors of degradation and some possible solutions; energy density; and accomplishments for FY 77 and FY 78. G.Y.

**N79-21576#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.  
**LEWIS RESEARCH CENTER PROGRAM**

D. G. Soltis In NASA. Goddard Space Flight Center The 1977 Goddard Space Flight Center Battery Workshop 1977 p 133-136

Avail: NTIS HC A25/MF A01 CSCL 10C  
As part of the NASA lightweight battery program, the Lewis Research Center has a number of programs that are being reviewed. A brief and general discussion of these programs is presented. G.Y.

**N79-21577#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**ACCELERATED TEST PROGRAM**  
Floyd E. Ford and J. M. Harkness (Naval Weapons Support Center) In its The 1977 Goddard Space Flight Center Battery Workshop 1977 p 137-140

Avail: NTIS HC A25/MF A01 CSCL 10C  
A brief discussion on the accelerated testing of batteries is given. The statistical analysis and the various aspects of the modeling that was done and the results attained from the model are also briefly discussed. G.Y.

**N79-21603\*** McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.

**THE 100 kW SPACE STATION**

George McKinnon /n NASA. Goddard Space Flight Center The 1977 Goddard Space Flight Center Battery Workshop 1977 p 451-461

Avail: NTIS HC A25/MF A01 CSCL 10C

Solar array power systems for the space construction base are discussed. Nickel cadmium and nickel hydrogen batteries are equally attractive relative to regenerative fuel cell systems at 5 years life. Further evaluation of energy storage system life (low orbit conditions) is required. Shuttle and solid polymer electrolyte fuel cell technology appears adequate; large units (approximately four times shuttle) are most appropriate and should be studied for a 100 KWe SCB system. A conservative NiH<sub>2</sub> battery DOD (18.6%) was selected due to lack of test data and offers considerable improvement potential. Multiorbit load averaging and reserve capacity requirements limit nominal DOD to 30% to 50% maximum, independent of life considerations.

Author

**N79-21604\*** Grumman Aerospace Corp., Bethpage, N.Y.

**THE 25 kN SPACE STATION**

Bruce Clark /n NASA. Goddard Space Flight Center The 1977 Goddard Space Flight Center Battery Workshop 1977 p 463-474

Avail: NTIS HC A25/MF A01 CSCL 10C

The capabilities of photovoltaic, nuclear reactor, and solar thermal systems are assessed for the space construction base. Topics covered include Brayton conversion, thermionic conversion, and thermo-electric conversion. The effectiveness of nickel cadmium and nickel hydrogen batteries are discussed as well as that of regenerative fuel cells. The verification of long cycle life for nickel hydrogen systems is recommended.

A.R.H.

**N79-21610\*** Eagle-Picher Industries, Inc., Joplin, Mo.

**MULTISTACK NICKEL-HYDROGEN UNITS**

Jim Smith /n NASA. Goddard Space Flight Center The 1977 Goddard Space Flight Center Battery Workshop 1977 p 519-524

Avail: NTIS HC A25/MF A01 CSCL 10C

A typical 625 Inconel pressure vessel, equipped with four thermocouples, has voltage taps not only for the cell, but for each of the several packs inside the container. In a two-stack design, a weld ring is used to separate the packs which, joined together, form one solid group. In the four-stack design, stacks are separated mechanically with about half inch Plexiglas and are connected through the center. Electrolytes are forced out by vacuum. The two stack design is intended for 500 psi and was pressure tested up to 1,000. The problem of electrolyte shorts is discussed and possible solutions for its correction are given.

A.R.H.

**N79-21618\*** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

**DEVELOPMENT, TESTING, AND CERTIFICATION OF THE NORTHROP, INC., ML SERIES CONCENTRATING SOLAR COLLECTOR MODEL NSC-01-0732 Final Report**

John C. Parker Mar. 1979 27 p refs (NASA-TM-78219) Avail: NTIS HC A03/MF A01 CSCL 10A

A summary is presented of the additional development work on the existing ML Series concentrating solar collector for use with solar heating and cooling systems. The report discusses the intended use of the final report, describes the development hardware, lists deliverable end items, deals with problems encountered during fabrication and testing, and includes certification statements of performance. This report shows that the products developed are marketable and suitable for public use.

L.S.

**N79-21619\*** Sunkeeper Control Corp., Andover, Mass.

**DESIGN PACKAGE FOR PROGRAMMABLE CONTROLLER AND HYDRONIC SUBSYSTEM**

Mar. 1979 28 p Prepared for DOE (Contract NAS8-32257) (NASA-CR-161151) Avail: NTIS HC A03/MF A01 CSCL 10A

Information used in the evaluation of design of Sunkeeper Control's electronic controllers and hydronic packages is discussed. This information includes system performance specifications, a design data brochure, drawings, and qualification and acceptance test procedures.

**N79-21620\*** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

**DEVELOPMENT, TESTING, AND CERTIFICATION OF OWENS-ILLINOIS MODEL SEC-601 SOLAR ENERGY COLLECTOR SYSTEM Final Report**

John C. Parker Mar. 1979 22 p refs Prepared for DOE (NASA-TM-78223) Avail: NTIS HC A02/MF A01 CSCL 10A

The final results are presented of the additional development work on the existing air-cooled solar energy collector subsystem for use with solar heating and cooling systems. The report discusses the intended use of the final report, describes the deliverable end items, lists program objectives, relates how they were accomplished, deals with problems encountered during fabrication and testing, and includes a certification statement of performance. The report shows that the products developed are marketable and suitable for public use.

L.S.

**N79-21621\*** Wyle Labs., Inc., Huntsville, Ala. Solar Energy Systems Div.

**LONG TERM WEATHERING EFFECTS ON THE THERMAL PERFORMANCE OF THE SOLARON (AIR) SOLAR COLLECTOR**

Mar. 1979 12 p refs Prepared for DOE (Contract NAS8-32036) (NASA-CR-161166) Avail: NTIS HC A02/MF A01 CSCL 10A

The test procedures and the results obtained during the evaluation test program on the Solaron Corporation air-type solar collector are presented. The tests were performed under simulated conditions, following long-term exposure to natural weathering conditions. The Solaron Model 2001, air-type solar collector has a gross area of 19 square feet and the weight is 160 pounds. The absorber plate is made of 24-gage steel, the coating is baked-on black paint, the cover consists of two sheets of 1/8-inch low-iron tempered glass, and the insulation is one thickness of 3 5/8-inch fiberglass battting.

L.S.

**N79-21622\*** General Electric Co., Wilmington, Mass. Aircraft Equipment Div.

**SOLID POLYMER ELECTROLYTE (SPE) FUEL CELL TECHNOLOGY PROGRAM Final Report**

22 Mar. 1979 73 p (Contract NAS9-15286) (NASA-CR-160159; TPR-59) Avail: NTIS HC A04/MF A01 CSCL 10A

The overall objectives of the Phase IV Solid Polymer Electrolyte Fuel Cell Technology Program were to: (1) establish fuel cell life and performance at temperatures, pressures and current densities significantly higher than those previously demonstrated; (2) provide the ground work for a space energy storage system based on the solid polymer electrolyte technology (i.e., regenerative H<sub>2</sub>/O<sub>2</sub> fuel cell); (3) design, fabricate and test evaluate a full-scale single cell unit. During this phase, significant progress was made toward the accomplishment of these objectives.

G.Y.

**N79-21624\*** Army Facilities Engineering Support Agency, Fort Belvoir, Va.

**ENERGY UTILIZATION SURVEY PAMPHLET FOR BUILDINGS Final Report**

Peter E. Baum and Harold D. Hollis 26 Apr. 1978 42 p refs (AD-A062930; USAFESA-RT-2052) Avail: NTIS HC A03/MF A01 CSCL 05/1

This pamphlet provides guidelines and forms to conduct an energy utilization survey of individual buildings and facilities on an installation. Forms are provided in this pamphlet for collection of information describing facility and individual building energy consumption. This information is needed to use energy conservation manuals which provide guidance on how to reduce and save energy through more effective operation of buildings and their mechanical and electrical systems, and through cost

N79-21625

effective retrofit of existing systems. A list of these manuals is provided in Appendix A.

Author (GRA)

N79-21625# Versar, Inc., Springfield, Va.

**ASSESSMENT OF COAL CLEANING TECHNOLOGY: AN EVALUATION OF CHEMICAL COAL CLEANING PROCESSES** Final Report, Apr. - Dec. 1977

G. Y. Contos, I. F. Frankel, and L. C. McCandless Aug. 1978  
299 p refs  
(Contract EPA-68-02-2199)  
(PB-289493/9; EPA-600/7-78-173a)

Avail: NTIS

HC A13/MF A01 CSCL 07A

Technical and economic information on chemical coal cleaning processes is assembled and assessed. Sufficient data was located to evaluate 11 processes in detail. It was found that chemical coal cleaning processes can remove up to 99% of the pyritic sulfur and 40% of the organic sulfur, resulting in total sulfur removals of 53 to 77%. This performance can be achieved with heat value recoveries of 57 to 96%. Processes which remove only pyritic sulfur were generally judged to have the highest probabilities of success. Of techniques which remove both pyritic and organic sulfur, the ERDA and GE microwave processes were judged to have the highest probabilities of success. GRA

N79-21626# Oklahoma Univ., Norman. Bureau of Water and Environmental Resources Research.

**ENERGY CONSERVATION THROUGH SOURCE REDUCTION** Final Report

George W. Reid and Chan Hung Khuong Nov. 1978 76 p refs  
(Grant EPA-R-804183)  
(PB-290126/2; EPA-600/8-78-015)

Avail: NTIS

HC A05/MF A01 CSCL 10A

Energy conservation through reduction in generation of post-consumer solid waste is reported. Output and input approaches to estimate the quantity and composition of post-consumer solid waste were reviewed. Estimates of energy consumed in the manufacture of discarded materials and in handling the solid waste are compiled. Potentials and possibilities of reducing refuse and estimates of corresponding energy savings were studied. Twenty examples of opportunities to reduce refuse at government, policy-maker, manufacturer, and consumer levels are proposed. The energy intensiveness of materials found in the waste stream, total energy residuals embedded in each material, and possible candidates for reduction with greatest energy savings are presented. GRA

N79-21626# California Energy Commission, Sacramento.  
**CONSERVATION WHERE IT COUNTS: ENERGY MANAGEMENT SYSTEMS** Final Report

Dick Foley Jan. 1978 14 p  
(PB-289837/7; CAEC-002) Avail: NTIS HC A02/MF A01 CSCL 13A

This report aids managers of commercial buildings or industrial plants in identifying energy waste and controllable energy loads, and in choosing the right load control system for heating, ventilating, and air conditioning (HVAC) equipment. A method for calculating a building's energy budget is explained, and the U. S. General Services Administration energy budget guideline is given as a comparison. Energy saving equations are provided to help establish realistic energy waste reducing goals. Techniques for reducing the operating time of lights and HVAC equipment -- demand limit load shedding, optimization of equipment running time, fixed start-stop schedules, and load cycling -- are discussed. The various types of control equipment, from elaborate central mini-computer or micro-computer systems to simpler and less expensive programmable controllers or disbursed black box systems, are described, and approximate purchase costs are given. Checklists for comparing hardware costs are included. GRA

N79-21630# National Bureau of Standards, Washington, D. C. Building Economics and Regulatory Technology Div.  
**INTERIM PERFORMANCE CRITERIA FOR SOLAR HEATING**

**AND COOLING SYSTEMS IN RESIDENTIAL BUILDINGS, SECOND EDITION** Final Report

John K. Holton Nov. 1978 113 p refs Sponsored in part by HUD

(PB-289967/2; NBSR-78-1562) Avail: NTIS  
HC A06/MF A01 CSCL 13A

The interim performance criteria, developed for the Department of Housing and Urban Development, are criteria and standards for the design, development, technical evaluation and procurement of the solar heating and cooling systems to be used in residential buildings during the solar heating and cooling demonstration program authorized by the Solar Heating and Cooling Demonstration Act of 1974. These interim criteria are intended primarily for use in the solar residential demonstration program and as a basis for the preparation of definitive performance criteria. GRA

N79-21631# NATO Committee on the Challenges of Modern Society, Brussels (Belgium).

**REPORT OF THE 4TH CCMS (COMMITTEE ON THE CHALLENGES OF MODERN SOCIETY) SOLAR ENERGY PILOT STUDY MEETING**

Sheila Blum and Redfield W. Allen Aug. 1978 159 p Conf. held at Dusseldorf, Germany, 17-18 Apr. 1978 Prepared in cooperation with Maryland Univ., College Pk.

(Contract EY-78-S-05-4908)  
(PB-289492/1; NATO/CCMS-84) Avail: NTIS  
HC A08/MF A01 CSCL 10A

The cost effectiveness and practical application of solar energy to heating and cooling in buildings were examined. The final Solar Energy Pilot Study Meeting is summarized, and recommendations for continued international cooperation are made.

Author

N79-21632# National Bureau of Standards, Washington, D. C. National Engineering Lab.

**EXPERIMENTAL VERIFICATION OF A STANDARD TEST PROCEDURE FOR SOLAR COLLECTORS**

James E. Hill, John P. Jenkins, and Dennis E. Jones Jan. 1979 131 p refs Sponsored in part by DOE  
(PB-289912/8; NBS-BSS-117; LC-78-600138) Avail: NTIS  
HC A06/MF A01 CSCL 14B

A proposed procedure for testing and rating solar collectors based on thermal performance was published by the National Bureau of Standards (NBS) in 1974. The American Society of Heating, Refrigerating, and Air Conditioning (ASHRAE) developed a modified version of the NBS procedure which was adopted in early 1977 as ASHRAE Standard 93-77. A test facility for water-heating and air-heating collectors was built at NBS and was used to support the development of Standard 93-77. The recently adopted test procedure, the NBS test facility, and the tests that were conducted to support the development of the procedure are described. GRA

N79-21640# Oak Ridge National Lab., Tenn.  
**AN INVENTORY OF ENVIRONMENTAL IMPACT MODELS RELATED TO ENERGY TECHNOLOGIES**

P. T. Owen, ed., N. S. Dailey, ed., C. A. Johnson, ed., and F. M. Martin, ed. Feb. 1979 410 p  
(Contract W-7405-eng-26)  
(ORNL/EIS-147) Avail: NTIS HC A18/MF A01

An inventory is presented which identifies and collects data on computer simulations and computational models related to the environmental effects of energy source development, energy conversion, or energy utilization. In addition to the standard bibliographic information, other data fields of interest to modelers, such as computer hardware and software requirements, algorithms, applications, and existing model validation information, are included. Indexes are provided for contact persons, acronym, keyword, and title. The models are grouped into the following categories: atmospheric transport, air quality, aquatic transport, terrestrial food chain, soil transport, aquatic food chain, water quality, dosimetry and human effects, animal effects, plant effects, and generalized environmental transport. G.Y.

N79-21661# TRW, Inc., Durham, N. C.

**EVALUATION OF DRY SORBENTS AND FABRIC FILTRATION FOR FGD (FLUE GAS DESULFURIZATION) Final Task Report**, Mar. 1976 - Oct. 1978  
 S. J. Lutz, R. C. Christman, B. C. McCoy, S. W. Mulligan, and K. M. Slimak Jan. 1979 155 p refs  
 (Contract EPA-68-02-2165)  
 (PB-289921/9; EPA-600/7-79-005) Avail: NTIS  
 HC A08/MF A01 CSCL 07A

The use of baghouses (fabric filtration) to control air pollutant emissions (particularly sulfur oxides) from large utility combustion sources was assessed. Sorbent costs, and system capital, operating, and disposal costs were determined. Sulfur dioxide would be removed by introducing powdered dry sorbent into the gas stream by precoating the baghouse fabric with sorbent. Whether the apparent economic advantage exhibited by the concept would remain intact after independent third-party evaluation, and if the economic (and other) advantages are sufficiently large to warrant further development of the process at field installations were evaluated. Results show that the dry sorbent baghouse FGD process exhibits an economic advantage when compared with current lime and limestone scrubbing technology when applied to Western power plants burning low sulfur coal.

GRA

N79-21662# Radian Corp., Austin, Tex.

**ENVIRONMENTAL ASSESSMENT: SOURCE TEST AND EVALUATION REPORT, CHAPMAN LOW-Btu GASIFICATION Final Task Report**, Sep. 1977 - Sep. 1978  
 Gordon C. Page Oct. 1978 257 p refs  
 (Contract EPA-68-02-2147)

(PB-289940/9; EPA-600/7-78-202) Avail: NTIS  
 HC A12/MF A01 CSCL 07A

The results of a source test and evaluation of a commercial Chapman low-Btu gasification facility are reported. The multimedia waste streams and potential fugitive emission and effluent streams from the facility were characterized. The applicability of Level 1 sampling and analytical methodology to such a characterization was evaluated. The particulate removal efficiency of the product gas cyclone was performed. Chemical and biological tests indicated that all multimedia waste and process streams examined contained potentially harmful organic and/or inorganic materials. The product gas cyclone was approximately 60% effective in removing particulate matter from the raw product gas stream.

GRA

N79-21670# Environmental Protection Agency, Research Triangle Park, N.C. Monitoring and Data Analysis Div.  
**NATIONAL EMISSIONS DATA SYSTEMS (NEDS) FUEL USE REPORT (1975)** Final Report  
 Apr. 1978 130 p

(PB-290162/7; EPA-450/2-78-018) Avail: NTIS  
 HC A07/MF A01 CSCL 21D

This report summarizes annual estimates of total consumption of major fuels such as coal, fuel oil, natural gas, gasoline, and diesel fuel. Estimates of the consumption of a number of other comparatively minor fuels are also included. The data are distributed according to major categories of air pollutant emissions sources and are reported for the nation as a whole and for individual states, territories, and the District of Columbia.

GRA

N79-21671# Hittman Associates, Inc., Columbia, Md.

**AIR QUALITY IMPACTS USING SRC VERSUS CONVENTIONAL COAL IN POWER PLANTS** Final Report, Nov. 1977 - Sep. 1978

Irving Leichter, R. C. Koch, N. L. Nagda, and J. L. Swift Oct. 1978 356 p refs  
 (Contract EPA-68-02-2162)

(PB-290237/7; EPA-600/7-78-023) Avail: NTIS  
 HC A16/MF A01 CSCL 13B

The results of air quality modeling to assess the impact of burning solvent-refined coal (SRC) instead of conventional coal in three power plants which exceeded National Ambient Air Quality Standards when burning conventional coal are discussed. The EPA CRSTER Gaussian plume model with minor modifications was used to calculate ambient air pollution concentrations (for

SO<sub>2</sub>, NO<sub>x</sub>, and particulates) when (1) conventional coal and (2) SRC were burned. SRC test burn emissions data were used to determine emission factors for the three pollutants when burning SRC at each plant. The most significant impact of switching from conventional coal to SRC was the reduction of SO<sub>2</sub> and particulate concentrations at each plant. The highest 20 maximum 24-hour SO<sub>2</sub> concentrations were reduced by 60-75%.

N79-21679# Argonne National Lab., Ill. Environmental Impact Studies Div.

**A BIOLOGIST'S MANUAL FOR THE EVALUATION OF IMPACTS OF COAL-FIRED POWER PLANTS ON FISH, WILDLIFE AND THEIR HABITATS**

B. G. Lewis, P. C. Chee, R. M. Goldstein, F. C. Kornegay, and D. L. Mabes Aug. 1978 226 p refs  
 (Contract W-31-109-eng-38)  
 (PB-291330/9; FWS/OBS-78/75) Avail: NTIS  
 HC A11/MF A01 CSCL 13B

This manual contains generalized summary of the major impacts to biota that are unique to coal-fired power plants. Power plant features and their impacts discussed in the manual include: gaseous and particulate stack emissions, coal slurry pipelines, coal cleaning and storage, limestone preparation and storage liquid effluents, solid wastes, and coal conversion. This manual, in conjunction with the detailed technical report, Impacts of Coal-Fired Power Plants on Fish, Wildlife, and Their Habitats, provides the information biologists need to have effective input to the power plant environment review process.

N79-21682# Wahler (W. A.) and Associates, Palo Alto, Calif.  
**POLLUTION CONTROL GUIDELINES FOR COAL REFUSE PILES AND SLURRY PONDS** Final Report, Dec. 1975 - Jul. 1977

Nov. 1978 228 p refs  
 (Contracts EPA-68-03-2344; EPA-68-03-2431)  
 (PB-291369/7; EPA-600/7-78-222) Avail: NTIS  
 HC A11/MF A01 CSCL 08I

A large percentage of the eastern coal mined today is washed and processed to remove impurities and increase quality. The wastes from the preparation process pose a serious disposal problem. Acid and heavy refuse piles, suspended solids in waters from refuse areas and slurry ponds, noxious gases from oxidation and fires in refuse piles, and airborne particulates from dry exposed refuse surfaces were investigated.

N79-21689 Michigan Univ., Ann Arbor.

**HEAT FLOW AND RADIOGENIC HEAT PRODUCTION IN BRAZIL WITH IMPLICATIONS FOR THERMAL EVOLUTION OF CONTINENTS** Ph.D. Thesis

Icaro Vitorello 1978 153 p  
 Avail: Univ. Microfilms Order No. 7907192

Heat flow and heat production results are reported from nineteen widely spaced sites in eastern and central parts of Brazil.

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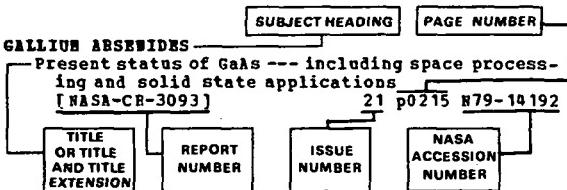
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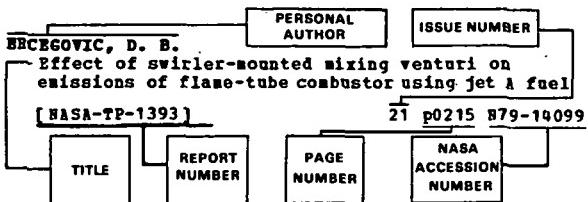
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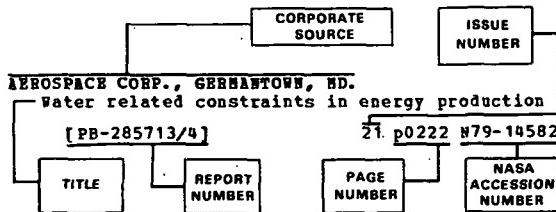
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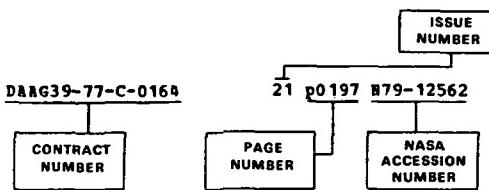
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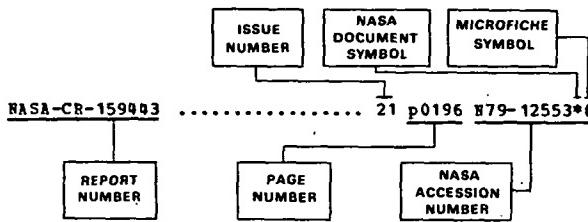
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